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PREFACE.

Under instructions of July 7, 1908, from the Secretary of the Interior I visited the Territory of Hawaii and made the memoranda submitted herewith relating to matters of interest in connection with the possibility of reclaiming the arid public lands and of utilizing these for homes.

I arrived in the islands on September 23 and left on November 18, being eight weeks in the Territory, spending the greater part of this in travel, during which time I made a circuit of the island of Oahu, visiting in order Maui, Kahoolawe, Hawaii, Molokai, and Kauai. In the course of the various trips I traveled approximately 700 miles on interisland steamers, 750 miles by carriage, automobile, or railway train, and 450 miles on horseback. I had an opportunity of meeting many people of the islands in their homes, as relatively little time was spent in hotels. I also had opportunities of being present at various popular gatherings and associations where matters of interest relating to the development of the Territory were discussed.

In making this report I have tried to present the larger features of a complex situation, and at the same time preserve a certain freshness of impression, amplifying the details which strike the newcomer and which are not readily found in reports or books on the islands. The impressions of a first visit differ widely from preconceived opinions obtained from reports or from descriptions which necessarily deal largely with special features. This will explain why I have gone somewhat fully into matters which are elementary to the people of the islands, but which seem to be overlooked by the average American citizen.

The descriptions of irrigation and other works dealing with sizes, capacities, and cost have been compiled from memoranda somewhat hastily prepared. There has not been opportunity for securing verification of these data from the owners or engineers of the works. The object of inserting the descriptions has been to call attention to the fact that considerable development has taken place and to indicate in a general way the character of this development. It is hoped that in the future a more careful description may be prepared of these works, and to this end information is being obtained to bring these statements up to date. The purpose of this report is amply served by calling attention to the present knowledge of the existing conditions.

In my trips among the islands I have had the advantage and personal pleasure of being accompanied by Gov. Walter F. Frear. His broad knowledge of local conditions has been invaluable. He has already thought out and called attention to or put into practice as

far as possible many of the important principles of conservation of the resources of the islands. His annual report exhibits concisely the existing conditions and calls attention to needed legislation in the line of progress. In it he emphasizes the fact that the sentiment among the thinking public on the islands is rapidly growing in favor of bringing in or encouraging the larger introduction of laborers who are or will become American citizens, thus gradually reducing the proportion of aliens, mainly Orientals, who form over half of the population.

A sentiment toward changing the character of the laborers from aliens to citizens has been aroused among the thinking people of the islands. It is accompanied by a realization of the fact that the laborers—who will be voters—must have a home and ownership of a small tract of land if they are to be a stable and conservative force in government. This brings us face to face with the overshadowing problem of home making and home preservation, and through home making the permanent increase of a working population with the civic capacity which is essential to the safety of an American commonwealth. Many attempts have been made in this direction with little success, but as a result of the experience had in the arid States and Territories it is believed that lands now arid and mainly in public ownership can be reclaimed, divided into small tracts, and the ownership gradually passed to American citizens, including both laborers and small farmers.

F. H. Newell.

December 21, 1908.

HAWAII.

INTRODUCTION.

The Hawaiian Islands are a part of the United States lying 2,000 miles off the coast of California and several hundred miles easterly from the farthest western possessions of the United States in Alaska. These islands are now and have been for eight years (since June 14, 1900) an integral part of the territory of the United States. This fact seems to be not generally appreciated by the great mass of citizens on the mainland. As a consequence, the opportunities offered by the islands and the duties of the United States as a whole to the Territory have been quite largely overlooked. The opportunities are those offered by a rich soil, a highly developed civilization, and, most notably, by a climate ideal as regards comfort and suitability for high physical development.

The duties of the nation to this Territory arise from the fact that this island outpost is the gateway through which passes most of the traffic to and from the Orient, and where diseases inimical to the human race, also the insect pests or blights injurious to animal and vegetable life, must be caught and destroyed or prevented from further progress. From the political standpoint the importance of keeping these islands thoroughly American in racial and social affinities can hardly be overestimated. There is not sufficient area to develop at once a State so great and independent that its demands will be prominent at the federal capital. It is therefore incumbent upon the National Government to see that this community is given the needed encouragement and support which will lead to its best development along traditional American lines.

The health of the body politic demands that this small but important territory should have a full recognition and constant consideration. It is unnecessary to enter upon any argument along military lines. This has been widely discussed, but it is significant to point out that this gateway to and from the Orient is the abiding place for Orientals now comprising 56 per cent of the population. Counting with these the peoples from southern Europe—landless and largely migratory laborers, with no inherent loyalty to republican institutions—the total forms nearly three-fourths of the whole population of the islands. Add to this the fact that the natives, who comprise nearly three-fourths of the voters, are still uncertain in their civil attitude—are easily swayed by specious arguments—and there arises a condition where common prudence demands careful thought, resulting in a definite plan, followed by action. There is a striking defi-

ciency in numbers of what have been called the "plain people"—citizens descended from generations of freemen—in whom thrift, energy, and civic virtues are inborn. This lack notably of the "small farmer" has long been recognized. It is the duty of the nation to assist in filling this need.

LAND SURFACE.

The land surface of the eight inhabited islands aggregates a little under 6,500 square miles, or, in round numbers, a little over 4,000,000 acres, being a little less than the area of the State of New Jersey. The largest island, Hawaii, has an area of 4,015 square miles, or about the same as Connecticut.

Compared with Porto Rico, which has an area of 3,435 square miles, the Island of Hawaii is one-sixth larger. In population, however, the islands as a whole have only about 170,000 persons, or 26 per square mile, while Porto Rico has about 1,000,000, or nearly 300 per square mile.

In extent the islands cover an area comparable to a belt extending diagonally across Colorado, as illustrated by figure 1.

The lands are made up almost entirely of lava flows, some of great antiquity, others quite recent. The upper layers of the older lavas, where they have decayed on the surface, furnish soils which, though very fertile, are frequently eroded by ravines or canyons. The lands covered by the most recent lavas are practically valueless, the rough surface, not yet disintegrated by the weather, being bare of vegetation and in many places impassable to man or beast.

On the 4,000,000 acres of land surface, probably one-third (see fig. 2) is of little or no use, consisting of fresh lava or of cliffs, canyons, and ravines too steep even for the growth of forest trees. The most valuable land is that now utilized for the growth of sugar cane. This aggregates about 213,000 acres, of which 34,000 acres belong to the Government. The cane land is located on the alluvial flats and lower slopes of disintegrated lava flows. Above or adjacent to these is the belt of land too high or too dry for sugar, but used largely for grazing. This aggregates about 1,500,000 acres. Higher up the mountain slopes, extending on the windward side to the tops of all but the highest mountains, are the forests, the collecting ground for the water supply of the lower lands. These embrace over 1,000,000 acres, of which three-fourths have been or will soon be set aside as territorial forest reserves. About 70 per cent of the area of the reserves belongs to the Territory, the remainder being in the hands of individuals or corporations, who are working with the territorial officials in preserving the forest cover.

Altitude and exposure to the wind governs largely the productive capacity of the land areas. The soil, though all of volcanic origin, varies in quality largely through differences in exposure to the weather, to dryness, and consequently to the degree to which the parent rocks have disintegrated.

At altitudes below 1,000 feet the climate is truly tropical, especially on the leeward or sheltered side, while on the mountain tops, above 10,000 feet, the climate is almost arctic in its severity. As a whole,

only about one quarter of the area of the islands is below 1,000 feet above sea level, another quarter is from 1,000 to 3,000 feet in altitude, and the remainder above 3,000 feet. It is in this belt of land above 1,000 feet and reaching well up on the mountain slope that the

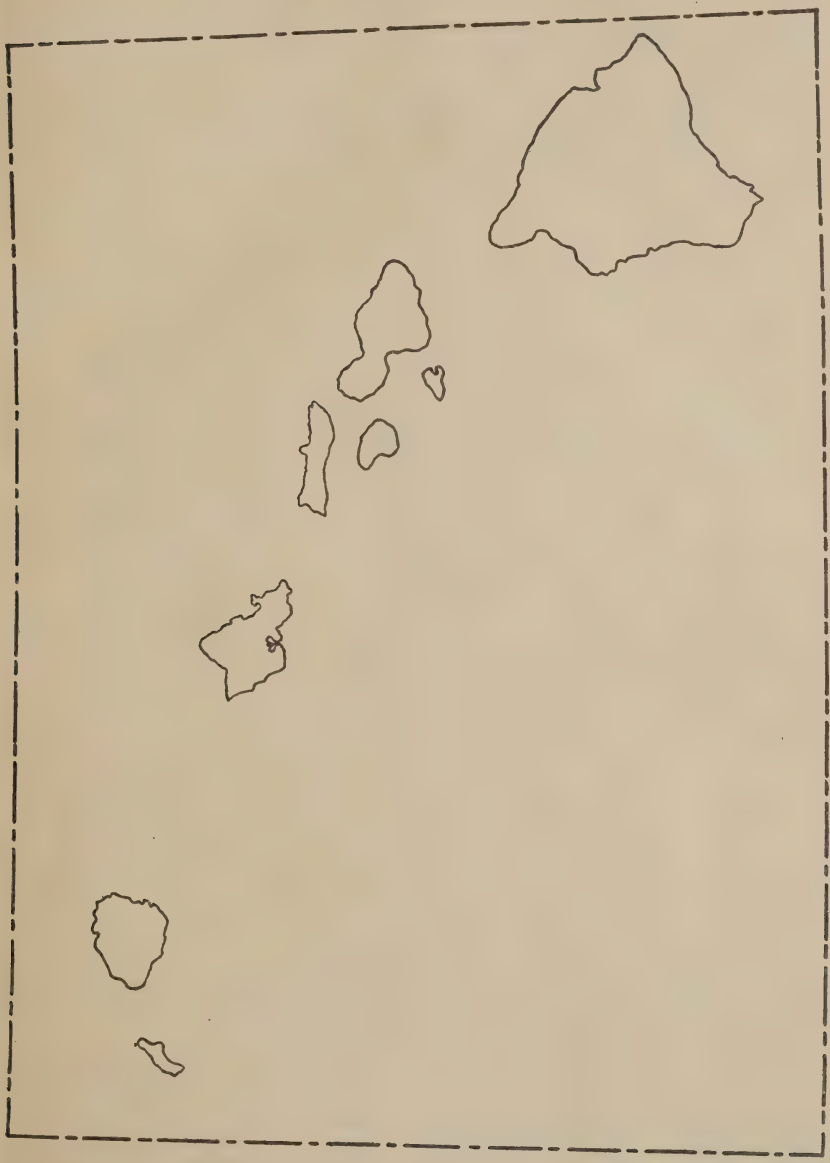

FIG. 1.—Area of Hawaiian Islands compared with area of Colorado.

highest development of small farming and diversified industries appear probable. The elevation is sufficiently great to insure a climate suitable for the comfort of the white race and yet is sufficiently warm for the raising of many valuable products.

ARID LANDS.

Over one-third of the entire land surface of the islands is arid for the greater portion of each year. Taking into consideration only the areas which possess a soil of agricultural value, it may be said that one-half of all the good soils of the islands require the artificial application of water to be of the highest value in crop production. Much of the lands now used for grazing can be utilized for crops if water can be had at the right time.

It is popularly supposed that the islands are saturated with moisture. This is because of the fact that at certain points, notably on the windward side, the precipitation is exceedingly heavy and has been

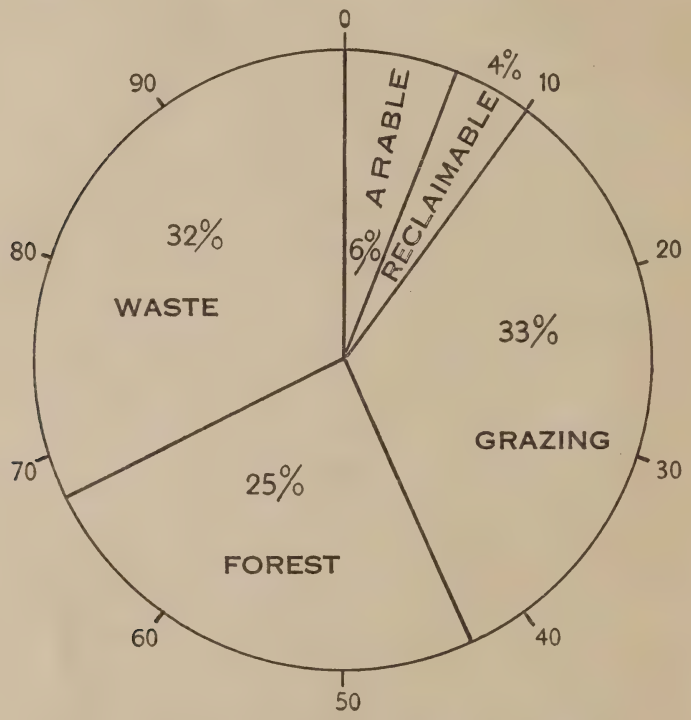

FIG. 2.—Classification of lands as regards character.

so frequently commented upon, that this fact of heavy rainfall at a few points has overshadowed the equally important fact that other parts of the islands have a deficient water supply.

LANDS IN PUBLIC OWNERSHIP.

The total area of public lands owned by the Territory of Hawaii is estimated at a little over 1,600,000 acres, or one-third the entire land surface. Practically all of this is under lease and is being put to some use. Much of it has little value, being composed of recent lava flows, or is cut up by great canyons. About 34,000 acres, or 2 per cent, is now in sugar cane, and about 500,000 is included in various ranches,

being cut up usually by stone walls into grazing fields or paddocks. Much of the remainder, or 273,912 acres, is included in territorial forest reserves, and additional area up to a total of about 300,000 acres will be thus set aside.

Many of the leases on the larger tracts of public lands were originally executed in the years from 1860 to 1890, and had a length of life of fifty years or less. As each lease expires the question arises as to the disposition to be made of this particular area. Thus the broad question as to the future of all the public lands has not been forcibly presented at any one time. Executive action in carrying out any future policy must await the opportunity when each lease expires in turn.

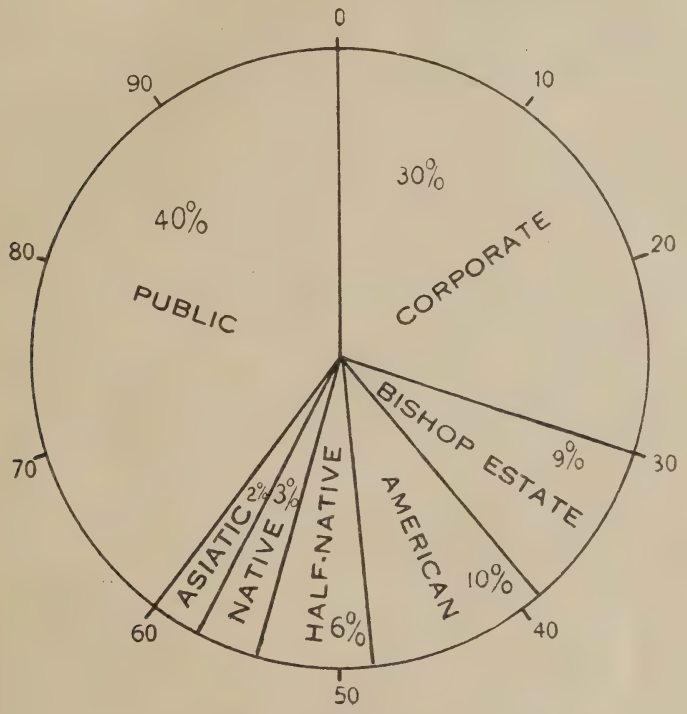

FIG. 3.—Ownership of lands.

There is little in the public land situation in the islands which is directly comparable with that on the mainland. On the islands the public lands are now, and have been for generations, occupied and put to some use. They are more or less highly developed, and are under cultivation as far as the arid conditions will permit. They can be compared, perhaps, most nearly to the abandoned military and similar reservations in the arid Western States, where houses have been built, ditches constructed, fields fenced, and a comparatively large population has found a home. They are included within or are bounded by tracts of private land of equal or greater size, which also have been occupied and used for generations. They do not, as on the mainland, consist of vast stretches whose resources are little

known and where the newcomer must select his homestead on untried areas remote from human habitation; on the contrary, most of the arable public lands on the islands show evidence of former occupation or agricultural improvement, and has been the home of generations of tillers of the soil. Every little hill and valley and each natural feature has now, or did have, a well-recognized name, and complicated rights of water have vested from time immemorial.

LANDS IN PRIVATE OWNERSHIP.

The title to all lands in private ownership dates from about 1848. Prior to that time the lands and waters belonged to the King and were divided by him among his chiefs or followers, who in turn alloted portions to the people. Land tenure was then comparable to that under the feudal system in Europe. In 1846 to 1855 a division of all lands was made, resulting in approximately the following allotments:

	Acres.
To the Crown	1,100,000
To the Government	1,413,000
To chiefs and people	1,647,000
Total	4,160,000

This ownership applied mostly to Hawaiians, as the laws until 1859 practically prohibited aliens from such land ownership. There were approximately 11,000 native owners who received an average of from 2 to 3 acres apiece, these being the small kuleanas or taro patches, occupied and tilled by each man at that time. This division of the land illustrates the fact that the needs of the common people were filled and a relatively high state of culture developed by individual work on very small tracts; in fact, the native under best conditions, can rarely make use of a larger area.

Bishop estate.—The largest private landowner in the islands is the Bishop estate, the lands being those resulting from descent in the extinct Kamehameha line of kings. At present these lands are held as a source of revenue to be devoted to certain schools. The estate is estimated to include 375,000 acres, or about 9 per cent of the entire land surface of the islands, but it is claimed that only 5 per cent of this 375,000 acres is suitable for agriculture. It is probable that in the case of any general system of reclamation being undertaken by the Federal Government this large estate as well as other landowners would cooperate in making available the reclaimable land for settlers on small tracts.

LAND SUBDIVISION.

The rectangular form of subdivision adopted throughout the greater part of the mainland, both in the United States and in Canada, is unknown in the islands, and is inapplicable to the physical and cultural conditions there existing. This system was originally devised for the broad prairies and plains of the West and is of a special value where the land is of uniform character for hundreds of miles. On the islands there is no such thing, the typical condition being that of a mountain mass sunk partly beneath the sea but with the top projecting out of the water. From the moun-

tain top the surface slopes in all directions to the shore. On the windward side this otherwise gentle slope has been abruptly terminated at the sea by erosion forming high cliffs and deep gorges. On the leeward side the slope has frequently been prolonged by coral reefs aided by soil washed or blown from the upper lands. Going

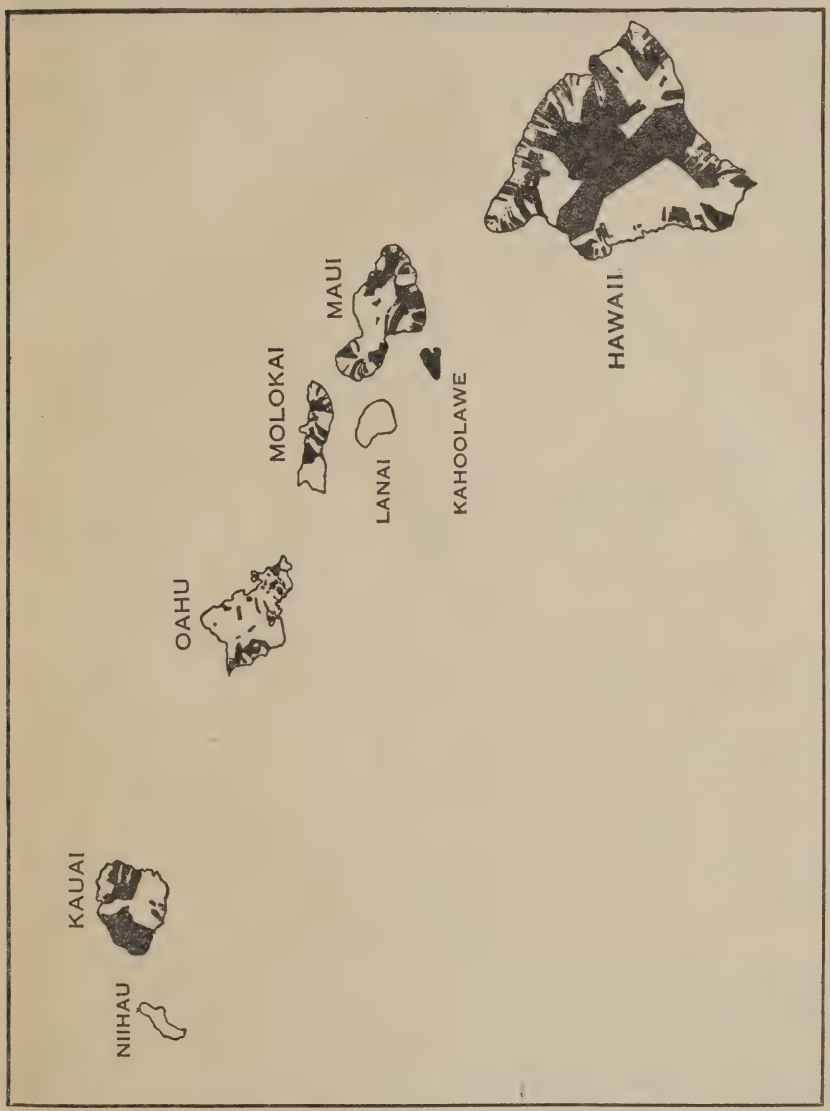

FIG. 4.—Distribution of public land. (Areas in solid black are public lands.)

around the islands there are belts or zones of land having similar climatic conditions, the successive zones becoming less and less tropical as the mountain side is ascended. These horizontal belts are, however, deeply cut by canyons or gorges, which radiate from the central cone.

This ideal arrangement is interfered with on several of the islands by the fact that there are two or more distinct mountain peaks, but the original subdivision of the land by the natives was made largely with reference to this typical condition of topography and of the common needs of the people. Each chief was allotted by the King a piece of land not lying in a continuous strip along the seashore or on the mountain side, but was given a wedge-shaped slice extending from a point at the mountain top down to the sea, widening out toward the shore. In this way each principal man had a part of the sea frontage for fishing, a little lowland for cocoanuts or taro, some higher ground for dry-land crops, above this some forest for wood for various purposes, including canoe making, and also some of the grazing or waste land. Thus a diversion was made of all classes

FIG. 5.—Classification of public land.

of surface, the size of each individual holding being proportional to the importance of the chief.

The adoption by the natives of this method of land subdivision is a natural consequence of the topographic structure. They had originally in their language no expression for the points of the compass, but instead of fixed directions commonly used two words, which pass current even with the white men, that is, the term "mauka," to signify toward the mountain, and "makai" toward the sea. It is curious to note that even though a man is accustomed through long usage to speak of directions as north or south, east or west, as is done habitually on the mainland, yet on coming to the islands he quickly falls into the habit of indicating directions by the simple

words "mauka" or "makai," as every point on the islands is thus quickly described with reference to other adjacent points. Instead of describing a place as being on the right or left hand side of the road, it is always "mauka" or "makai" of the road.

These native subdivisions, or ahupuaas, the result of years of experience, became crystallized into definite holdings at the Mahele of 1848. Their boundaries were as a rule general in character, and it has been a work of great magnitude to establish and mark upon the ground the exact limits of these ahupuaas. This delimiting each holding would have been comparatively easy were it not for the fact that within each of these larger holdings there are smaller tracts, averaging 2 or 3 acres, kuleanas of the natives. To each of these there attaches a more or less definite right to certain waters used from time immemorial in cultivation of taro or other crops on the kuleanas.

The descriptions of all lands, whether public or private, is necessarily by metes and bounds and not by any simple numerical system such as that made easy by the rectangular surveys on the mainland. Every tract of land, no matter how insignificant, has its individual name. From the fact that the Hawaiian alphabet is limited to a few letters, and certain syllables are in frequent use, it results that the names of these lands are frequently similar in sound or the same name is repeated in various localities and are thus confusing to the stranger.

The land surveys, considering the difficulty of the work, have been made with extraordinary accuracy. They are based upon triangulation, and the original maps are a matter of public record. Titles may be registered and transferred by the Torrens system.

LAND VALUES.

Land values appear to be very high compared with those existing throughout the arid West of the United States. It is, however, difficult to make comparisons as the crop-producing capacities of the lands are so different. On the sugar lands, for example, eighteen months is required for producing a crop, while in the case of some other products two or even three crops a year can be had.

Few if any agricultural lands are on the market. Even city or suburban lots were obtainable with great difficulty until within a few years. The lack of real estate agents in the islands is very noticeable, especially when a person has become accustomed to the constant importunities of men offering agricultural and other lands for sale in the vicinity of every town or city on the mainland.

Leasing real estate instead of selling is prevalent, and it is a matter of surprise to learn the large sums received for tillable lands, such as those rented by the orientals, notably the Chinese, for rice production; $20 to $25 per acre per year is not uncommon, and instances have been seen where rents as high as $40 or even $60 per acre per year are collected. For banana land the prices may be from $5 to $15 per acre. The tendency is for the orientals, and to a less extent the Portuguese, to rent rather than obtain an absolute title to the land. It is impossible to assign any one cause for the condition, anomalous in American territory, of high rentals and few if any sales.

The origin of the custom lies in the history of the land titles and in the peculiar character of the population. Up to the time of the establishment of a permanent government there prevailed such uncertainty as regards the future that investors preferred to keep their money in negotiable securities. Even after the establishment of the territorial government there was little tendency to invest in land or speculate in the rise in value of real estate. The sugar planters have, of course, endeavored to purchase the lands needed for their business. Failing in this they have leased from the government, the Bishop estate, and other holders. The lands which might be useful for other purposes have not as a rule been put upon the market and would-be purchasers of small tracts have difficulty in obtaining any land suitable for farming.

The leasing system has been denounced by some as the curse of the country, although it is recognized that there are conditions such as those surrounding the occupation of the land by the natives where the long-time lease is the only way by which they can be assured of a permanent home. The high prices of land have also forced men of small capital to lease land so that they might use their resources in cultivation and marketing the crops.

WATER SUPPLY.

There is probably no part of the United States where in as small an area there is as great a diversity in the quantity of water and its availability. At one point the annual rainfall may be over 300 inches in depth; only a few miles distant, extreme aridity prevails. Even with the heavy rainfall on the mountain slopes, which are exposed to the trade winds, there are relatively few rivers or living streams. Much of the water sinks into the porous lava and penetrates to the innumerable pipes or tunnels left by the fluid rocks as they originally flowed toward the sea.

Units of measurement.—In statements regarding the quantities of water the unit commonly employed in the Hawaiian Islands is the United States gallon of 231 cubic inches. The flow of streams is given in millions of gallons per twenty-four hours. Transferring this unit to the one in ordinary use in the United States of the cubic foot per second (or second-foot), there is found to be a convenient relationship in that a stream delivering a million gallons during twenty-four hours is equivalent to a flow of a little over 1.5 second-feet. The second-foot is roughly equivalent to two-thirds of a million gallons per twenty-four hours, or is 50 "miners' inches," thus making the million gallon per twenty-four hours equivalent to about 75 miners' inches.

The common unit of volume of water—for example, that contained in a reservoir—is in the United States the acre-foot (43,560 cubic feet). A volume of a million gallons is thus equivalent to 3.06 acre-feet, or 1 acre-foot equals a little less than a third of a million gallons.

Duty of water.—The duty of water in irrigation of the arid lands is stated generally to be a million gallons per twenty-four hours, flowing continuously, for 100 acres of sugar cane. Many soils require a larger quantity of water and a million gallons (or 1.5 second-feet) will irrigate considerably less than 100 acres, in some cases as low as 60 acres or even less, where the ground is excessively sandy or porous.

The sugar cane is grown in furrows about 5 feet apart, into which water is turned from the distributing ditches. The newly planted seed is watered every three or four days. Later, water is applied once in ten to sixteen days if available. If water can not be had, the sugar cane will continue for some weeks or even months without serious deterioration, but will not make any notable growth. There is a limit to its endurance, and when once passed subsequent irrigation will not revive the plant. Sufficient water is applied to the cane fields to cover them to a depth of from 10 to 12 feet each year. Without irrigation sugar cane is said to yield a profit where the rain is not less than 3 inches each month.

Not only is water developed for use in irrigation, but it is also employed in creating electric power, which, after transmittal, is in turn used for pumping water for irrigation. Large volumes are also used for conveying the ripe sugar cane to the mills from the fields situated at distances of several miles and at several hundred feet greater elevation. Many of the cane fields are on steep slopes, and from these it is impossible to convey the cane at reasonable cost excepting by flowing water. The water is conducted in V-shaped flumes built of so-called "northwest" lumber or Douglas fir. The California redwood is more permanent as regards freedom from decay, but has been found to be too soft for conveying the cane, as the friction quickly wears it out.

Prices of water.—Water for irrigation is not generally sold, most of the ditch systems having been built by the plantations. In a few cases water not needed by the plantation has been sold at the rate of from $6 to $8 per million gallons, or, in round numbers, from $2 to $2.50 per acre-foot.

For a continuous flow of water the prices have ranged from $2,000 to $3,600, or even in one case as high as $6,250 per annum per million gallons per twenty-four hours of continuous discharge. This is at the rate, in round numbers, of $1,400 to $2,400 up to $4,000 per cubic foot per second, a price which would be prohibitory in the arid region of the United States, as on a basis of 100 acres to the second-foot this would be an annual charge of $14 to $24 or $40 per acre. The highest charge known on the mainland, excepting in extraordinary emergencies to save an orchard, is rarely above $5 a year per acre.

IRRIGATION DEVELOPMENT.

There are now under irrigation, mainly in sugar cane, about 110,000 acres. The investment in ditches, tunnels, reservoirs, pumps, etc., amounts to over $15,000,000, or at a rate of about $140 per acre. The older ditches—some in rock tunnel—were begun by the natives in prehistoric times. The latter larger works have been built mainly by the sugar planters.

Irrigation development in the islands differs widely from that on the mainland in the character of construction and cost per unit of water handled. On the mainland the greater part of the water is taken from perennial streams and carried in broad, shallow canals having a capacity of several hundred cubic feet per second. On the islands most of the water is taken from very small streams. The ditches head in high and exceedingly rough mountain regions, the

ridges being so narrow and the slopes so steep that the water is conveyed largely in tunnels. The tendency is more and more to do away with open ditches, and practically honeycomb the catchment region with underground works.

Storage reservoirs on the islands are small compared with those on the mainland. There are no large natural basins adapted to holding water. In most cases the underlying rock, consisting of lava, is very porous, and water is held only by the relatively thin layer of soil on top of the lava, in which there is usually little or no clay. On the island of Hawaii considerable difficulty has been experienced, as the soil of the basins there used as reservoirs has been penetrated by roots, which, decaying, form almost innumerable passages from the surface to the porous lava. Water may stand in such a reservoir at a depth of say 10 feet without serious loss, but when the height is increased to say 15 feet many holes will develop. Attempts have been made to pack the soil by turning in cattle and sheep, in the hopes that the constant tramping will close all openings. Expensive tests have also been made of various ways of plowing the soil and subsoil and compacting this by heavy rollers or hammers. In each case, although temporary relief has been had, the increase of pressure on the reservoir has resulted in breaking through the earthy lining. The cost of completely stripping the reservoirs and of relining them is practically prohibitory.

Pumping water for irrigation has been developed on the islands to an extent far in excess of anything in the United States, over 60 per cent of the water used on plantations being pumped. On the mainland a height of 30 or 40 feet is considered for most crops the limit, but in the islands with higher crop values pumping to 10 times this height is not unusual. Much valuable experience has been obtained as a result of experiments made on a large scale with various forms of pumping apparatus. The direct-acting, slow-moving pump has been generally done away with, and most of the new pumps are of the relatively high speed, fly-wheel type, with triple expansion cylinders and piston velocity up to 500 feet per second. These elevate water to a height of a little under 200 feet up to a maximum of 550 feet, at a cost of approximately $7.85 per million gallons (or $2.50 per acre-foot) for 100-foot lift. For different heights the costs are given as follows per million gallons:

Cost of pumping, per million gallons.[a]

100-foot lift	$7.85
200-foot lift	11.57
250-foot lift	13.44
300-foot lift	15.30
350-foot lift	17.17

There are reported to be 111 pumps in operation, with a capacity of 580 million gallons for twenty-four hours, or 900 second-feet, supplying about 60,000 acres of land, about a million gallons to 100 acres or 1 second-foot to 64 acres. One acre requires about 5 million gallons or 15 acre-feet to produce a crop.

The following paragraphs give some of the more striking details of the irrigation works now in use:

HAWAII.—On the largest island of the group, Hawaii, having an area of over 4,000 square miles, there is a much larger proportion of

[a] Planters Monthly, October, 1904, p. 417.

cultivated land depending directly on rainfall than on the other islands. Of the six districts in which the island is divided, there is only one, that embracing the greater part of the Kohala Mountains, in which irrigation construction has reached a considerable degree of completeness. On the windward side, throughout the greater part of the Hamakua coast, and especially in the Hilo district, there is an abundance of rainfall, and the principal use of water by the sugar plantations is in conveying sugar cane from the fields to the mills. In Puna the rainfall is also usually sufficient for crops. The westward or Kona side of the island, although protected from the trade wind, has considerable rainfall, this being due probably to the fact that the great height of Mauna Loa gives rise to local precipitation independent in part of the typical island conditions.

In the district of Kau, on the extreme southern side of the island, water has been developed mainly for use in fluming sugar cane by means of tunnels driven into the forested slopes at altitudes of about 4,000 feet. There is not a sufficient precipitation to form perennial streams similar to those on the Hamakua side, but there are innumerable marshes or soft places where small quantities of water can be collected by tunnels driven a short distance beneath the surface. It has been found as a rule that deep tunnels do not obtain any considerable increase of water over those that penetrate to a horizontal depth from about 100 feet to 150 feet.

Along the seashore, especially near Punulua, are many fresh-water springs, resulting from the fact that most of the rainfall on this side of the island penetrates beneath the surface and, gathering presumably in volcanic pipes or tunnels, finds its way to sea level. Many attempts have been made to trace the course of these underground or percolating waters, but with little success. It is believed, however, that the value of the water is such as to justify further systematic search carried on under the guidance of a competent geologist and engineer. It is probable that no investment will yield larger returns to the plantations than a small amount of money systematically expended under competent guidance through a number of years.

In the extreme northern part of the island in the Kohala Mountains there has been considerable activity in ditch construction. Here are found also prehistoric ditches popularly said to have been built by Kamehameha I, but probably antedating his time. The excavation of the solid rock in the process of tunnel building is especially notable because of the fact that this was done by stone implements, the rock being presumably first disintegrated by fire.

Most of the water occurs at or near the summit of the Kohala Mountains and on the northeastern or windward slope. This has been deeply cut, forming great canyons or gulches with nearly vertical sides. There has recently been built two water-supply systems, one known as the Kohala ditch, extending northwesterly parallel with the coast and capable of extension to reach arid lands on the western slope of the Kohala Mountains; the other system consisting of the upper and lower Hamakua ditches extending easterly and southerly toward the Hamakua district.

Kohala ditch.—This ditch, completed in January, 1906, supplies water for the Kohala plantations, in the extreme northerly part of the island of Hawaii. It receives the water at an elevation of 1,030

feet from Honokane and adjoining streams. In ordinary seasons it carried about 20 million gallons per day, and has an extreme capacity of 70 million gallons. The flow of 1907 varied from a maximum of 30 million gallons in July to a minimum of about 10 million gallons in November. For a great part of its length it is in tunnels, there being 44 of these, 7 feet high and 8 feet wide. Fourteen miles of ditch have been built out of 21 miles projected. The cost is estimated at $600,000.

Upper Hamakua ditch.—This heads in the Kohala Mountains, about 5 miles south of the head of the Kohala ditch, and at an elevation of about 4,000 feet. It receives water from several small streams before these fall over the palies or cliffs into the Waipio Valley. It continues, by a series of tunnels and semicircular steel flume running along the upper edge of the palies, through the forest reserve and easterly to the open country, where a series of small reservoirs are being constructed. The total length is 23 miles. The flow is 11 million gallons per day, and the capacity of the reservoirs 350 million gallons. The cost was about $300,000.

Lower Hamakua ditch.—This ditch heads near the intake of the upper Hamakua ditch, but about 3,000 feet lower. It receives water from springs and also a small quantity from the surplus left by the upper ditch. Its tunnels are in a general way parallel to the upper ditch covering the lower part of the same plantations; flow, 65 to 70 million gallons per day; cost, $800,000.

Maui.—The principal sources of water on this island are on the northeastern side, on the windward or Koolau district. Here, as in the case of the Hamakua coast on Hawaii, the rainfall retained for a time in the marshy forested area soon finds its way into the deep canyons which run back from the coast. A number of ditches have been built, intercepting waters of the small streams and taking these out by means of tunnels carrying the water northwesterly to the depression or low-lying plain which lies between the two great mountain masses which make the island. Here the climatic conditions are such as to render sugar cane highly productive. The earlier ditches took water out at elevations of about 200 feet, but later and more complete systems bring it to higher altitudes.

The western portion of this depression is also supplied with water from the mountain region of west Maui.

The earliest ditch on Maui, known as the Hamakua ditch, was built by H. P. Baldwin in 1878 to take water for the Haiku and neighboring plantations. The next year another ditch, known as the Haiku ditch, was built in the same section by Claus Spreckels, to take water to the vicinity of Spreckelsville. This is about 20 miles long, has a capacity of 50 million gallons daily, and delivers water at an elevation of 250 feet. This ditch was later supplemented by the Lowrie ditch, built in 1900, delivering water at an elevation of 450 feet.

Lowrie ditch.—This is one of the earlier ditches on the island of Maui. It was completed in September, 1900, with a capacity of 60 million gallons. Its total length is 22 miles, of which 4 miles consist of tunnels, 1 mile of flumes, and 17 miles of open cut. In ditches built at a later date the proportion of tunnels has been increased, as the experience with this ditch has shown that greater

economy is secured by keeping the ditch under ground as far as possible.

The ditch heads at Kailua at the same point with the older Haiku ditch. The latter delivers water in the vicinity of Spreckelsville at an altitude of 200 feet, while the Lowrie ditch delivers it at an altitude of 457 feet. The total cost is approximately $250,000. Several siphons have been built with a diameter of 44 inches. The total area irrigated is 6,000 acres.

Koolau ditch.—This was built for the Hawaiian Commercial and Sugar Company, supplying water to the Haiku and Paia plantations. It was completed in 1904. It is 10 miles long of which nearly 8 miles are in tunnels. There are 38 of these. They are 7 feet high with a maximum width of 8 feet. The daily capacity is 85 million gallons. It takes water from the Nahiku rain belt at an elevation of 1,250 feet and discharges into the lower older ditches. The tunnels were excavated by Japanese working with hand drills, and the finished cost was about $7 per linear foot. The cost was approximately about $315,000.

Waihee Canal.—This takes water from the Waihee stream and carries it to the sugar lands in the vicinity of Wailuku on the island of Maui. The head is at an altitude of 650 feet and on the stream at a distance of 2½ miles from the ocean. The total length is about 10 miles, of which over 3 miles is in tunnels, numbering 22, with a height of 6½ feet and greatest width of about 6½ feet. There are also 39 flumes. This ditch is 225 feet above the level of the old Waihee ditch. Starting from a dam in the Waihee stream, the ditch passes along the south bank and into a series of tunnels to the north bank of the Iao Valley, back of the town of Wailuku; this valley is crossed by an inverted siphon. The water is then conveyed to new cane lands near Waikapu and Puuhele, where there are located several reservoirs. The steel pipe crossing Iao Valley is 1,250 feet in length and 3 feet inside diameter. The capacity is 45 million gallons per day, or about 70 second-feet. The cost was about $160,000.

Honokahau ditch.—This ditch, on West Maui, has a capacity of 30 million gallons daily; it is 13½ miles long and has 200 feet of 36-inch siphon pipe and 3½ miles of tunnels. It cost $185,000, and delivers water at 700 feet elevation. It takes water from the Honokahau Valley to the cane fields in the vicinity of Lahaina.

Molokai.—An attempt was made about 1900 to develop water for irrigation for the lands on the south side of the island by means of artesian wells. Large expenditures were incurred in erecting pumps, laying out cane fields, building a railroad, and putting up buildings, but after the pumping plant was installed it was found that the water obtained was too brackish for irrigation. The work was at once abandoned without, apparently, testing the limits of supply. The water resources of the island have been reported upon by Waldemar Lindgren, an abstract of his report being printed as "Water-Supply Paper No. 77" of the United States Geological Survey.

Oahu.—The principal part of the water supply comes from the Koolau Range on the windward or northeasterly side of the island. The amount obtained from relatively small forest-covered areas is remarkably large. There is also a very heavy artesian flow obtained on the southerly side of the island, where there are found a number of large springs. The water rises in the artesian wells from 25 to

35 feet above sea level. It is pumped to altitudes as high as 500 feet above sea level. The aggregate yield of all the wells on the island is roughly estimated at 300 cubic feet per second.

Several storage reservoirs have been built, the most notable of which is that at Wahiawa. A dam 136 feet high and 461 feet long has been built below the junction of the forks of the Kaukonahau stream, and forms a narrow, winding lake extending for 7 miles through the fields of the Wahiawa Colony. The total drainage area above the lake is 8,000 acres, located on the slope of the Koolau Mountains. The capacity of the reservoir is 2,500 million gallons, or about 7,500 acre-feet. The cost was $300,000. Water is used for the Waialua plantation, the outlet of the reservoir extending through 4 miles of ditch and tunnels and issuing on the sugar lands at an elevation of 730 feet above sea level. This ditch brings 12,000 acres of cane land under gravity flow. The altitude of the reservoir is about 1,000 feet. The water is sold at the rate of $6.17 per million gallons, and is measured by automatic registers.

Water for the Wahiawa land is not obtained from this reservoir, but by a ditch system at a higher altitude, taking water from the Koolau Mountains through 4 miles of main ditch, including 38 tunnels. This ditch was used during the construction of the dam for sluicing earth. It not only supplies water to the colony lands, but will be used for power purposes, the surplus flowing into the reservoir.

KAUAI.—The greater part of the water supply of this island comes from the high mountain or plateau on the north side. The fall of the streams is very rapid, there being many localities where power has been and can be developed.

Beginning on the southwest side of the island and extending easterly around the island, the principal works for supplying water are as follows:

Kekaha ditch takes its water from Waimea River, 8 miles from the sea, at about 550 feet elevation. It passes through a series of tunnels and crosses Waimea Valley by means of an inverted siphon of 48 and 42-inch diameter, 2,190 feet long. The tunnels are 6 feet high and 8 feet wide, and have an aggregate length of nearly 2 miles. The ditch has a capacity of 55 million gallons per day above the siphon and 45 million gallons below. The water supplying the lowland is used to develop 750 horsepower. Other drops can also be utilized. The total cost was $275,000.

Waimea River also supplies the town of Waimea by a conduit having a capacity of 6 cubic feet per second.

The Makaweli lands are supplied by two ditches, the first the Hanapepe, built by H. P. Baldwin in 1890, taking water from the stream of that name; the second the Olokele ditch, built in 1903. The Hanapepe ditch delivers water on the plantation at an elevation of 450 feet. It has over 7,000 feet of 40-inch riveted steel siphon, over 1,000 feet of tunnel, and nearly 3 miles of flume in a total length of 10 miles of ditch. The capacity of the Hanapepe is 35 million gallons. The Olokele ditch delivers water at an altitude of 1,075 feet and has a capacity of 60 million gallons. It has 8 miles of tunnel 7 feet high and 7 feet wide. The total cost was $360,000. A drop has been obtained for use for electrical power; reservoirs have been built to regulate the supply.

The McBryde plantation has several storage reservoirs for storm water with a permanent flow from mountain streams. The principal supply, however, is pumped from wells by power obtained from a hydro-electric plant on the Waniha River on the north side of the island. This was finished in August, 1906, and is one of the most notable developments in the Territory. The power canal heads at an elevation of 710 feet and extends with a fall of 2 feet in a thousand for a distance of about 7 miles at an altitude of 655 feet. There are 32 tunnels 6 feet wide and 6 feet high, the total length of these being a little over 3 miles.

At the end of the power ditch there are two 42-inch outlets having a length of 1,700 feet and dropping from an altitude of 655 feet to 90 feet above sea level. The pipe tapers to 30 inches where it enters the power house. The water is delivered against two Pelton wheels, direct connected to two 1,200-kilowat generators. From the power house power is transmitted over a pole line 35 miles long, practically encircling the island and leading to the pumps of the McBryde plantation. Power is generated at 2,200 volts and transmitted at 33,000 volts, aluminum wire being used. The efficiency of the apparatus has been estimated as follows: Water wheel 80 to 83 per cent, generator 95 per cent, step-up transformers 97 per cent, line 92 per cent, step-down transformers 97 per cent, and motors 92 per cent. Taking this into account the amount of power actually delivered 35 miles away is 61 per cent of the theoretical power in the water. With an efficiency of 76 per cent from the pumps the total water which can be delivered will be 46 per cent of the actual water flowing into the pipe line above the power house. (See also page 26.)

What is known as the Marsh reservoir of the Koloa plantation has a capacity of approximately 1,500 million gallons, or 4,500 acre-feet. It is located in the southern part of the island of Kauai, and receives water mainly from storms on the drainage basin of the river, increased by water brought by the Wilcox ditch from Kuia River in Lihue. This has a capacity of 80 million gallons per twenty-four hours. The cost of construction of this reservoir and feed ditches was a little over $100,000. The annual cost of maintenance of the system, including loss of crop from the land covered by the reservoir, is $16,000.

On the easterly side of Kauai, in the vicinity of Lihue, in Kapaa, and adjoining lands, water for irrigation is derived from small mountain streams, several storage reservoirs having been built for regulating this.

RECLAIMABLE LANDS.

The impression derived from a general examination of lands and waters on the islands leads to the belief that there are excellent opportunities for reclamation of public and private lands suitable for homestead purposes. The sugar companies have, as a rule, already irrigated most of the lands suitable for the production of cane, but there are considerable tracts of other lands not as well adapted to sugar cane which will have a great value when water is brought to them and they are intelligently cultivated. It is not practicable nor would it be desirable to attempt to point out at this time any particular localities, but sufficient has been seen to justify a thorough

survey and examination such as would result from the making of a topographic map, the measurement of streams, and the combining of the facts thus obtained with necessary engineering data.

It is probable that over 100,000 acres of land now practically useless or furnishing only indifferent grazing can be reclaimed. Any estimates at the present time must be mere guesses, as there are no general data on the water supply available or the opportunities for storing floods. On this basis, however, it would be possible to furnish 5,000 farms having an average size of 20 acres each. This would be ample for most purposes, although in some instances the area of the farm should be larger, in others smaller. In laying out these farm units, they would probably include, besides an average of 20 acres of irrigated land, an additional area not irrigated, but suitable for other agricultural purposes, such as pasture and places for buildings.

On this basis there would be added to the population of the Territory at least 20,000 persons, including 5,000 land-owning voters.

Before any comprehensive system of reclamation can be wisely undertaken, either under territorial or federal auspices, it will be necessary to bring together all available data, and with these as a basis to take up systematically the collection of knowledge of the surface elevations and of the water supply; in other words, it is essential to have a good contoured topographic map of the islands such as that being made by the United States Geological Survey throughout the arid regions. Such a map, showing all elevations of the surface, the location of streams, and the position of the forested areas, gives at a glance the outline of the catchment of the streams, the position and size of natural reservoir sites, and other facts needed in a general cognizance and broad understanding of the relative position of the mountains, the streams, and the irrigable lands. There are, of course, other engineering data which must be studied and obtained by subsequent field examination, but the topographic map is the basis on which general plans must rest.

Coordinate with the making of a good contour map should be carried on the systematic examination of the water resources. Much valuable information has already been brought together by individuals and corporations in connection with the proposed development of specific areas. Much of this material can doubtless be had by official inquiry, but it must be supplemented by further and more general investigation. It should be rounded out by studies relating to all of the streams, as well as those now known to be needed for particular tracts of land.

Work of this kind has been conducted systematically since 1888 by the water-resources branch of the United States Geological Survey under general authority of law to investigate the extent to which the arid regions can be reclaimed and under specific appropriations for such work. The same system should be extended on this territory of the United States.

Through the information thus given by a contour map and by data on stream flow, it will be possible to make broad and comprehensive plans for development of waters by tunnels, by storage reservoirs, by pumping, or other means. These plans, not confined to any particular tract of land, will necessarily be somewhat ideal in character, but once having the ideal system fully in mind it will then be practicable to fit this system in part at least to existing conditions of vested

rights in lands or waters. Experience on the mainland has shown that, having a broad, comprehensive project, it has been possible to adjust the various difficulties or complications of vested rights and to secure a favorable outcome without recourse to condemnation or any form or force other than the pressure of enlightened public opinion.

With the knowledge at hand it is apparent that there are excess or flood waters and some reservoir sites not yet utilized, and various tracts of public and private land which can be reclaimed, but to determine whether these particular localities are the best there must be a broad survey or general "taking account of stock."

WATER RIGHTS.

On the mainland two distinct systems are recognized as regards ownership and control of the flowing waters: First, that in the eastern humid States, where riparian rights prevail and where each landowner is entitled to enjoy in perpetuity the flow of streams along or through his land, undiminished in quantity and quality; second, in the arid States, where water is the basis of all land values and where the doctrine of appropriation prevails.

In the most advanced stage of the theory of appropriation, the ownership of all flowing water resides in the people. Any individual can lay claim to unappropriated water, and having put it to beneficial use is thereafter entitled to continue that use. The first in time is first in right, and beneficial use is the basis, the measure, and the limit of that right. Position on a stream or away from it confers no benefits, as a prior appropriator, located near the lower end of the stream or 10 miles away from it, can compel persons above him or nearer the stream to permit the water to pass by them untouched.

In the Hawaiian Islands a system radically different from either of these has grown up, largely as the result of ancient usage. There water is considered as appurtenant to the land upon which it originates and as belonging to the owner of that piece of land. He may lease it or sell it separate from the land itself, and may convey it to distant tracts of land, subject, however, to any vested rights which may come down from ancient times or more recently have been acquired by prescriptive use, such, for example, as the rights of the natives to the use of the water on their small taro patches. Riparian rights do not appear to be recognized excepting for water for domestic purposes, nor does the theory of appropriation hold excepting in the cases above noted of ancient or prescriptive rights which have grown up through the needs of the people.

There is no system in vogue of ascertaining officially the amount of water available nor the amount which has already been claimed and put to use. There appear to be many unsettled questions which must be taken into consideration in advance of any future general system of development; in fact, an essential preliminary to any thorough project of utilizing the water resources of the islands is the preparation of a code of water laws covering the question of ownership and control of the flowing streams and of the waters which may be held in storage reservoirs.

WATER POWER.

The absence of coal and similar fuel, the limited supply of firewood, and high price of imported fuels have resulted in attention being directed to water as a source of power for pumping for irrigation and for other incidental purposes. A report on the subject has been prepared for the territorial conservation commission by Alonzo Gartley, chairman of a committee on waters. From this report the following general facts have been obtained: Among other matters, it is pointed out that developments have already been made which are of considerable economic value, and there are great possibilities for future development. At the present time practically all the water power is in use generating electric power to supply motive power for irrigating pumps, the most important one being the Kauai Electric Company on the island of Kauai, where two 1,200 kilowatt generators are installed in Wainiha Valley, on the north side of the island, utilizing some 40 million gallons per day (or 60 cubic feet per second) at a head of 575 feet. Power is transmitted 35 miles around the island to the south side of the McBryde Sugar Company's plantation and there utilized in operating six multiple-stage centrifugal pumps direct-connected to motors of an aggregate horsepower of 4,000. These pumps have a capacity of 31 million gallons, or 45 second-feet, at a head of 175 to 400 feet, thus serving to irrigate over 3,000 acres of cane. (See page 23.)

At Kekaha, Kauai, water is taken from a high-level irrigating ditch and dropped 275 feet to irrigate the low-level lands. At this point a 600-kilowatt generator is installed to furnish power for four motors direct-connected to multiple-stage centrifugal pumps having an aggregate horsepower of 700, the pumps having a capacity of 7 million gallons at a head of 300 feet. The water for these pumps is taken from an irrigating ditch and pumped to a level above the ditch, thus rendering 700 acres of good cane land available.

The Pioneer Mill Company, at Lahaina, Maui, has installed a 250-kilowatt generator, operated by water power, which furnishes current for a 200-horsepower motor operating a triplex reciprocating pump which delivers 9 million gallons of water against a head of 100 feet.

The Oahu Sugar Company, on the island of Oahu, takes water from an irrigating pipe line and develops 120 kilowatts which supplies a 100-horsepower motor direct-connected to a centrifugal pump.

The Makee Sugar Company, at Keakia, Kauai, has installed and in operation a 300-kilowatt generator supplying current to a 225-horsepower motor operating a reciprocating pump having a capacity of 2.8 million gallons of water against a head of 250 feet.

The Waianae Sugar Company, on the island of Oahu, has installed two 200-kilowatt generators supplying current to motors of 375 horsepower to pump 6.5 million gallons of water against a head of 150 to 280 feet.

The Hilo Electric Light Company, on the island of Hawaii, develops 750 horsepower to operate a generator of an aggregate capacity of 450 kilowatts to supply light and power for the city of Hilo.

The Territory of Hawaii has installed and has in operation in Nuuanu Valley, island of Oahu, water-power-driven generators of 400 kilowatts capacity for supplying arc lights and territorial government lighting in the city of Honolulu.

There are several small water-power developments in mills varying from 10 to 50 horsepower which are used for operating machinery or electric generators.

The aggregate of these developments is approximately 6,500 horsepower.

It is impossible to make an estimate of the prospective power development, and at best only a few can be mentioned. These are such powers as have been rendered available through partial developments made for irrigating purposes, or where the possibilities are self-evident. The conservation and development of water at high levels for irrigating purposes will render many other plants both possible and expedient. A close approximation of the ultimate possibilities can only be made when complete surveys of the watersheds, records of the rainfall, and the cost and economic value of the developments are obtained.

The island of Kauai presents a fertile field for future development, and there are at the present time some 2,000 horsepower additional at Wainiha which is not being utilized; possibly 4,000 horsepower at Hanalei; and 1,500 or 1,800 horsepower at Makaweli; 500 or 600 horsepower at Hanapepe, and by the development of reservoirs back at Waimea, Wahiawa, Koloa, Wailua, Kapaa, Anahola, and Kalihiwai several hundred horsepower can be made available.

On the island of Oahu possibly 2,000 horsepower can be developed at Wahiawa and from the new high-level reservoir in Nuuanu Valley.

On Maui the Hawaiian Commercial and Sugar Company at Kanai and in Iao Valley can develop about 2,500 horsepower; and there are several hundred horsepower available at Waihee in the development of the Wailuku Sugar Company. Some 1,200 horsepower could be rendered available at Lahaina from the development of the Pioneer Mill Company.

The power resources of the island of Molokai are practically undetermined.

On the island of Hawaii it is estimated that in the Waipio Gulch some 8,000 horsepower can be rendered available by the present irrigating-ditch development, and on the north coast from Waipio to Hilo there are large quantities of water going to waste, or in use for fluming cane, which could be developed. No estimate of the amount of this power is available, but it would amount to several hundred horsepower.

Storage capacity constructed in the Kohala Mountain would render power available, but at present the quantity is entirely undetermined.

At many places the permanency of the flowing streams is not assured, but the development of storage capacity would render the power secure, and in many cases would increase the estimate of the amount available. However, the broken character of the country where these powers are available and the limited amount of arable land and water available for this land make the economic value of the development of these powers questionable.

The production of fertilizers from atmospheric nitrogen by the use of electricity may render the water power extremely valuable at such places where the power can not be used for pumping water for irrigating purposes.

FOREST PRESERVATION.

The primary need for forest preservation on the islands arises from the fact that the permanent water supply comes mainly from forest areas, and its quantity and time of occurrence is vitally affected by the character of the forest. There is probably no part of the United States where the relations between available waters and forest cover are more intimate and more delicate. The natural balance is easily disturbed. Changes made by man, too slight to be noticed by ordinary observation, have produced disastrous results.

The island forests have use as furnishing a wood supply and some commercial timber, but, speaking broadly, nine-tenths of the value of the forest resides in its protection of the water supply. The rapid diminution in area of the forest has led to corresponding decrease in available waters and to the abandonment of hundreds of acres formerly cultivated, but now barren of vegetation.

The retreat of the forest has been due primarily to unregulated grazing. Cattle, sheep, and goats tramping through the forest eating some of the underbrush produce a condition which, although hardly visible to the eye, is unfavorable to the best growth of the forest. With weakened vitality the trees quickly succumb to the attacks of insect pests or blights. These enemies exist at all times, but under a healthy and undisturbed condition of the forest their presence is not apparent.

The very delicate relations which exist can hardly be appreciated unless by actual observation. A forest absolutely free from intrusion by cattle will usually have its floor covered with a heavy plant growth; the soil is marshy to a degree that it is almost impossible to traverse the area. Let a few cattle run in the forest, making paths and nipping the younger foliage, and that although the absence of the plants can hardly be detected, yet there is a rapid drying out of the ground. The stranger will see an apparently untouched forest, and yet he finds that the soil is not marshy, and that the trees have begun to assume an unhealthy appearance and pests abound.

It results from the peculiar character of the forests that, as a rule, lumbering can not be carried on, nor the mature trees removed without destruction of the forest or injury as regards its capacity to protect the water supply. This is notably the case with the Ohia Lehua (*Metrosideras polymorpha* Gand), where the cutting of the larger trees lets in the sunlight and quickly results in destruction of the wooded area. This important tree is parasitic in origin, has no tap root, and depends for its life largely on protection afforded by smaller trees and shrubs. In the case of the Koa, the so-called Hawaiian mahogany (*Acacia Koa* Gray), the conditions are different, as the removal of the older trees is not so injurious, and if men and cattle are excluded and the Hilo grass (*Paspalum conjugatum* Berg) gains no foothold, the young Koa trees will rapidly increase and in ten or fifteen years a good start toward commercial timber can be had.

There are a few forests so situated that their influence on the water supply may be neglected, and these can be safely lumbered without injurious effects, but taking the forests as a whole, it must be said that the development of the islands requires that they be

permanently reserved, protected by fencing, and carefully supervised by qualified rangers. In this respect a beginning has been made, but it is apparent that larger expenditures are absolutely necessary to afford full protection to the forest growth, and consequently to the water supply upon which in turn depends the value and capability of the agricultural lands to support a dense population.

FIG. 6.—Forest areas. Forest reserves in black; natural forests not reserved indicated by diagonal lines.

The general conditions of the forests have been discussed by a subcommittee of the Territorial Conservation Commission of Hawaii, consisting of Ralph S. Hosmer and Alonzo Gartley. From their unpublished report the following facts are taken. This report calls attention to the fact that for a clear understanding of the forest situation in Hawaii it is necessary that one be acquainted with the

conditions of topography and local climate. As the Hawaiian Islands lie in the belt of the northeast trade winds and are mountainous, they have a climate characterized by contrasts. On the windward slopes of the mountains is an area of high precipitation; in the leeward districts scant rainfall, even approaching aridity, is the rule. These facts, coupled with the remarkable porosity of the soil, due to its volcanic origin, have a very direct bearing on the forest situation.

There are two main classes of forest in Hawaii. Both are of economic value; one because it helps to conserve the water needed for irrigation, power development, and domestic supply; the other because it produces wood and timber. The forests of the former class are, as a rule, situated on the moist, windward slopes of the higher mountains. They are essentially "protection forests" in that their main value rests in the water that can be got from them. Those of the latter class, the commercial forests, are found in the districts where because of the absence of running streams watershed protection does not figure. The forests of the first class are by long odds the most important, for in Hawaii the relation between sustained stream flow and a watershed protected by a forest cover is intimate and peculiarly direct.

Hawaii is a country essentially dependent on agriculture. The main crop is sugar cane. On more than half of the plantations irrigation is essential for successful cultivation, for although the soil in the leeward districts is rich, it requires water to be made commercially productive. Water is also needed on the nonirrigated plantations for the development of power and for the fluming of cane. The important part that irrigation plays in Hawaii may perhaps be made more apparent by the statement that over $15,000,000 has been expended, wholly by private enterprise, in developing the irrigation systems that supply water to the cane fields of the irrigated plantations.

The importance of the forest is generally recognized in Hawaii and has led to a strong public sentiment in favor of forestry. This finds expression in a Territorial Forest Service charged with the creation and administration of forest reserves and with the prosecution of other forest work. During the past five years under a definite forest policy systematically followed 16 forest reserves have been set apart, with an aggregate total area in 1908 of 444,116 acres. Of this area 273,912 acres, or 61 per cent, is land belonging to the territorial government. The remainder, 170,204 acres, or 39 per cent, is in private ownership, but for the most part the owners of the lands, fully aware of the benefits of forest protection, cooperate actively with the territorial government in the management of the forest reserves.

There are three main types of forest in Hawaii, the Koa and Ohia forest lying between the elevations of two and six thousand feet; the Mamani forest, a pure stand of another native Hawaiian tree, found on the upper slopes of the higher mountains; and the introduced Algaroba forest, which occurs at the lower levels on the leeward side of each of the larger islands.

The typical Hawaiian forest is of the first type. The forest consists of a dense jungle of trees, high-growing shrubs, tree ferns, and climbers, with much undergrowth and a heavy ground cover of ferns

and bracken. Altogether it is a plant community admirably adapted for the conservation of moisture, for preventing erosion, and for serving as a reservoir to feed the springs and streams that rise within its bounds. The most important trees are Ohia Lehua (*Metrosideros polymorpha*) and Koa (*Acacia Koa*).

The forest in all the forest reserves is of this type. A recent compilation of the forest areas of the Territory shows that the Koa and Ohia forest covers approximately 1,175,000 acres. Of this area it is estimated that eventually about three-quarters of a million acres will be included within forest reserve boundaries, of which about 70 per cent will be Government land.

Above the level of the Koa and Ohia forest, on the slope of Mauna Kea (elevation, 13,825 feet) on the island of Hawaii, is found a nearly pure stand of another native Hawaiian tree, Mamani *(Sophora chrysophylla)*. This forest occurs in a belt lying between the elevations of 6,000 and 8,500 feet. The area of the Mamani forest on Mauna Kea is 63,500 acres. Mamani occurs elsewhere in the Territory, but does not at the present time form what may be called forests. It is, however, spreading rapidly, so that in future years it will play a much larger part than it does now.

Mamani makes excellent fence posts, for which purpose the trees in the upper forest belt are cut for local use. No accurate figures as to the number cut are now available. Otherwise this type of forest is unimportant commercially.

The Algaroba *(Prosopis juliflora)* is the mesquite of the southwest. This tree was introduced into the islands in 1837. It has now spread so as to cover between 50,000 and 60,000 acres below an elevation of 1,000 feet in the leeward districts of the larger islands of the group. It is spreading rapidly along the leeward coasts and is also gradually climbing to a higher elevation.

The algaroba forest is the largest single source of fuel supply in the Territory. It is estimated that over 3,000 cords are sold annually in Honolulu. The price varies from $12 to $14 a cord, delivered.

The algaroba forests are further of value because the pods make good stock feed and also because the tree is one of the important plants locally for bee food. It is estimated that for the calendar year 1907 the total amount invested in apiaries and other equipment for the manufacture of algaroba honey was $125,000 and that the gross receipts for algaroba honey products for the year were over $25,000.

It has already been shown that the primary value of the Hawaiian forest rests in the influence it exerts on the conservation of water, and that the commercial aspect relatively takes second place. But in the leeward districts on the island of Hawaii are considerable areas where owing to the great porosity of the soil there are no permanently running streams. Here the main value of the forest rests in the wood and timber that it can be made to produce. The two Hawaiian woods of commercial importance are the koa and ohia lehua. Both are heavy, close-grained hardwoods. Koa is used for interior finish, furniture, cabinetwork, and veneering. It is now sold in the markets of the American mainland under the name "Hawaiian mahogany." Ohia is valuable for railroad ties. The systematic lumbering of this class of Hawaiian forest began in October, 1907, when a contract for 90,000,000 board feet of ohia railroad tie

material was made between a local company and the Santa Fe Railway Company.

A tie mill with a daily capacity of 2,500 ties has recently been erected. The first regular shipment of ties is to be made in the winter of 1908–9. No accurate estimate either of the amount of timber or the exact area covered by forests of the commercial class have yet been made, but the area is sufficient and the stand heavy enough to justify the continuation of lumbering operations for a considerable time.

The fact that none of the native trees in Hawaii furnishes construction timber has led to extensive tree planting, both by the territorial government and by private interests. This work has been going on for the last thirty years and is constantly increasing in extent and importance. The trees principally planted are several kinds of eucalyptus, the Australian ironwood and silk oak, and the Japanese cedar. Wood and timber cut from the planted forests in Hawaii are now being used for fence posts, railroad ties, bridge timbers, and wagon work. Practically all the construction timber used in Hawaii is imported from Puget Sound and northern California, mainly redwood and northwest (Douglas fir).

In the reports of the United States Department of Commerce and Labor it is stated that for the fiscal year ending June 30, 1907, there were imported into Hawaii from the mainland 30,603,000 feet b. m. of timber, boards, and planks, valued at $565,425. For the same year 17,476,000 shingles, valued at $39,207, and other unmanufactured lumber to the value of $116,756 were also imported, making in all a total of $721,388 for unmanufactured wood products. The value of manufactured wood products imported during the same fiscal year was $214,648. Further comment on the desirability of doing even a little toward securing a local source of supply is unnecessary.

A forest fire law similar to that of California was enacted by the territorial legislature at the session of 1905. The territorial superintendent of forestry is ex officio chief firewarden, and provision is made for a corps of district firewardens to be paid for duty actually performed.

As a matter of fact plantation managers and other influential citizens agreed to take these positions without remuneration. The law provides penalties in case of damage resulting from the careless or malicious use of fire. Since its enactment there have been few fires of consequence, due in large part to a better public sentiment created by the presence of the law on the statute books and to the interest aroused in the matter at the time of the enactment of the law.

INSECT PESTS AND BLIGHTS.

In consideration of new agricultural industries or increase of present products one of the greatest difficulties met is in the insect pests or blights. When the islands were first discovered the country was singularly free from these. The fly and mosquito quickly came with the Europeans, and from time to time other insects have been accidentally introduced. Freed usually from natural enemies the conditions on the islands have been remarkably favorable for the spread of insect life as well as of plants and animals. The uniform climate, the absence of frost, the fertility of the soil, and the absence

of enemies have resulted in a rapid spread of new life almost unprecedented in the history of other parts of the world. This is true also of parasitic or similar diseases of men and animals. The islands have furnished a wonderful breeding ground and field for experiment.

A recognition of this fact has led to the establishment of as strict a quarantine as possible, not only against the diseases of human and animal life, but also against the enemies of plant life. This quarantine, however, was begun too late to intercept some of the worst pests. Already the losses to the sugar business alone through insects have amounted to millions of dollars annually. It has thus been necessary to vigorously fight these pests and endeavor to restore the equilibrium, such as that brought about by nature in other parts of the world.

The first and most obvious method of fighting insect and other pests is by direct attack, by poisoning, or mechanical traps. The failure of such methods in the case of many of the common insects and vermin is attested by the fact that although white men have been carrying on this warfare for ages, the ordinary household pests flourish throughout the civilized world, notably the common house fly, rats, mice, mosquitoes, fleas, etc. On the islands surprising progress has been made along a different line, namely, that of fighting the foe by enlisting its natural enemies. The most striking case of success in this line has been the victory over the leaf hopper, a small fly which literally swept out of existence thousands of acres of valuable cane and threatened to bankrupt the sugar men. This insect was probably introduced from the Orient; innumerable devices were tried for killing it by spraying and other mechanical means. It was reasoned, however, that in the country from which it probably came there must be natural enemies to prevent its becoming conspicuous, as it was not known to have wrought serious injury elsewhere. Accordingly, search was made for its habitat, and this being found, its natural enemies were also discovered, brought to the islands, cultivated, and given facilities for attacking the leaf hopper. The result has been phenomenal and is a striking tribute to the sagacity of the men who initiated and financed the investigation, and both from a scientific and business standpoint carried it to a conclusion. In a single season the pest was reduced to insignificant proportions, and the last year's sugar crop, that of 1908, amounting to 521,123 tons, has exceeded all anticipations.

Other destructive insects have been introduced, and in spite of precautions it is possible that still others will come. The most destructive now known to the interest of the small farmer is the so-called "melon fly" (*Dacus cucurbitæ coq.*), which destroys cucurbitaceous vegetation, or the gourd, cucumber, tomato, and similar plants, largely raised for home consumption as well as for shipment. This fly now greatly injures the gardens on the islands and efforts are being made to prevent its spread to California. To guard against further introduction of similar pests, it is necessary to maintain a strict inspection of all vegetable products brought from the Orient.

The history of the introduction of new species of animal and vegetable life in the islands is exceedingly interesting, as each in turn disturbs the balance of natural conditions which had been previously estab-

lished and results often injuriously or beneficially to human health or business prosperity. It is impossible to predict what success will be obtained with any given new plant, because its enemies are not known; in the same way it is difficult to anticipate the benefits or injury from bringing in a new animal. The story of the mongoose is well known, this little animal being introduced to keep down the rats, but it soon became a question as to whether the benefits in killing rats were made up by the injuries in destroying birds and barnyard fowl. Great care is being taken in regulating experiments of this kind to see that no further mistakes are made.

On these islands, isolated for centuries, the life, both animal and vegetal, has developed along lines entirely different from that on the continental areas, being relieved largely from competition with other migratory life. The natives, freed from contact with other races, have not had the advantage which results from the weeding-out process due to the continual introduction of various diseases. Thus it has resulted that the island life is peculiarly susceptible to invasion and responds very quickly to any disturbing influence.

POPULATION.

The population of the islands has declined rapidly within the historic period. Tradition has it that the population had already begun to decrease notably when the islands were visited by Capt. James Cook in 1778. His estimate was approximately 400,000. After the visits of Europeans, the decline was accelerated by introduction of epidemic diseases, and notably from time to time by virulent outbreaks of smallpox and measles. The lowest point in total population, that preceding the influx of Orientals, was reached about 1875, when the total number of inhabitants was not much over 56,000. The natives have continued to steadily decrease in number, but there has been a slight increase in part-Hawaiians resulting from the union of natives with the whites and Asiatics.

The number of whites from America and Europe has steadily increased from the time of the visit of the whaling fleets. The most notable addition to the population has been through the introduction of Orientals as field laborers. The Chinese began to come in small numbers about 1870, the flood rapidly swelling and reaching a maximum about 1896. Since annexation in 1898 as a result of the application of the exclusion law, the number of Chinese has decreased.

The Japanese began to be brought to the islands about 1886 and have come in larger and larger numbers until in 1908 they formed the greater part of the population, being estimated at 72,000 out of a total population of 170,000, or 43 per cent of the total. There are also about 5,000 Koreans in addition.

The necessities of cheap and effective laborers on the sugar plantations has led to a search throughout the entire world for suitable men. The history of the efforts made in this direction is instructive, although the results have not been wholly satisfactory from the planters' standpoint. The chief white labor is now Portuguese, largely from Madeira and Fayel, these having been brought to the country at various times, the principal influx being about 1880. The

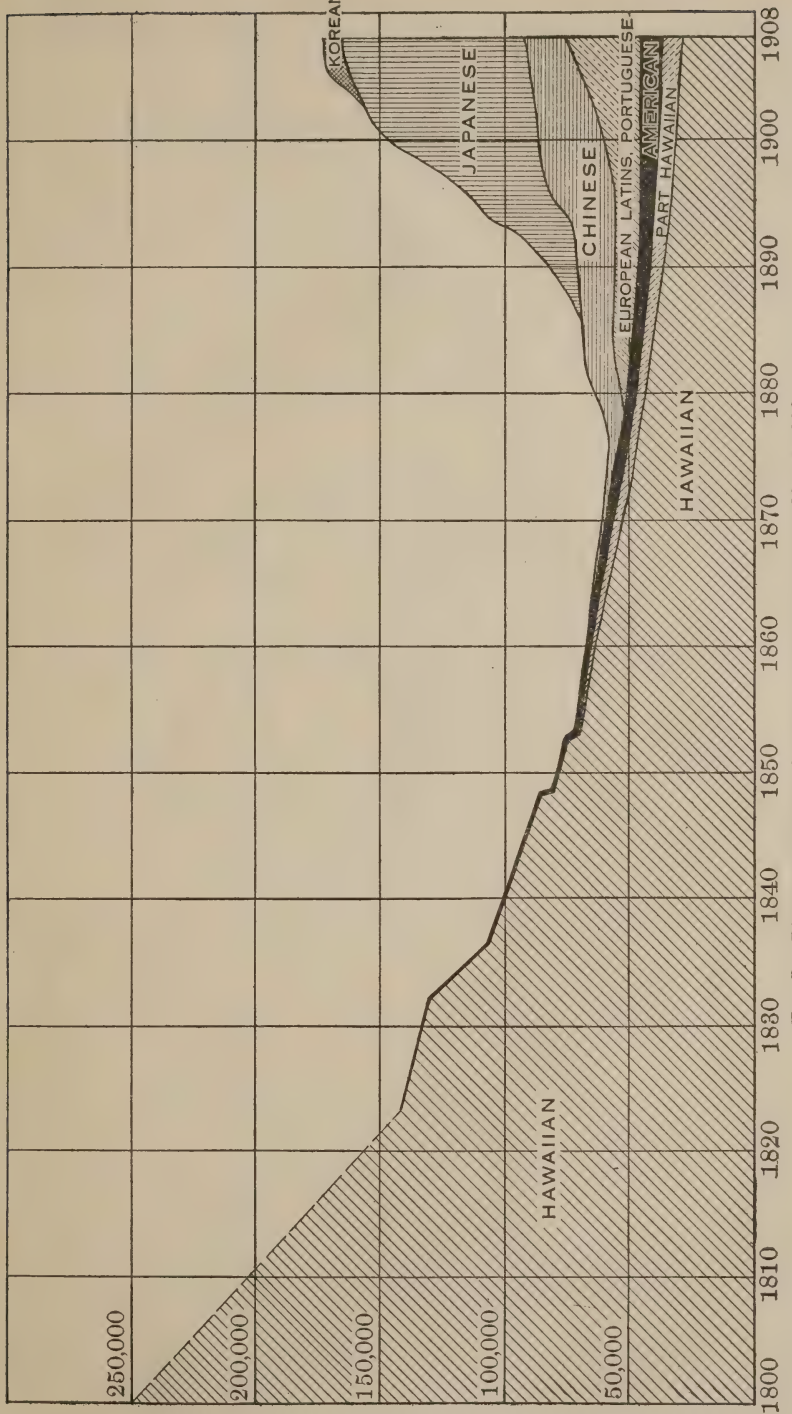

FIG. 7.—Diagram showing changes in population from 1800 to 1908.

last estimate of population, that in the report of Governor Walter F. Frear for 1908, gives the population in round numbers as follows:

Population of Hawaiian Islands.

Hawaiian and part Hawaiian		35,000
Teutons, including Americans, English, German, and allied races		12,000
Latins:		
Portuguese	23,000	
Spanish	2,000	
Porto Ricans	2,000	
		27,000
Oriental:		
Chinese	18,000	
Japanese	72,000	
Korean	5,000	
		95,000
Others		1,000
		170,000

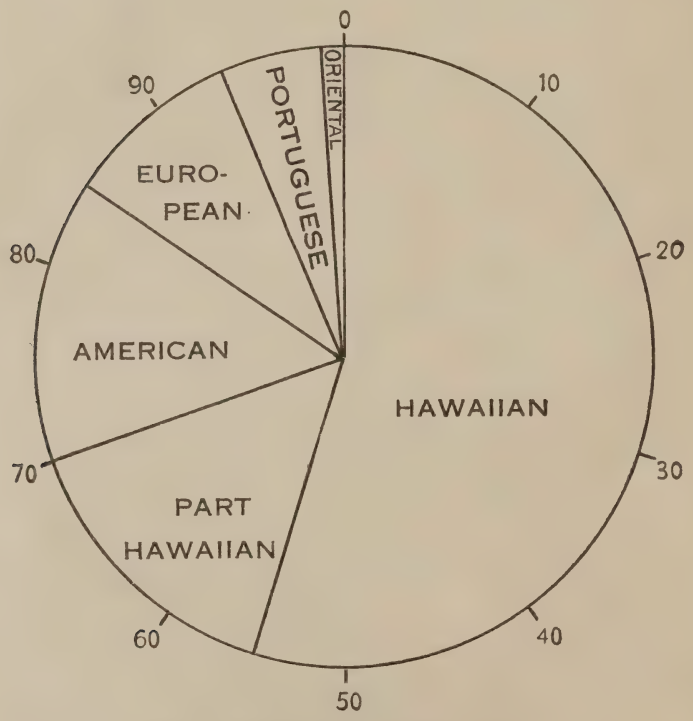

FIG. 8.—Nationality of voters in 1908.

Although the Orientals aggregate 95,000 or 56 per cent of the population they can under existing law have no part in the civil government. Thus the greater part of the population of the islands are aliens not eligible for citizenship. Comparing the voters with the total population, it may be said that of the Hawaiians and part Hawaiians 1 person in 4 is a voter. The same proportion holds in the case of those of American or northern European origin. In the case of the Portuguese or southern Europeans, 1 person in 30 is a voter. Among the Chinese, 1 in 100, and among the Japanese

1 in 10,000 is a voter from the fact that he was naturalized before annexation.

This proportion will change rapidly as the children now in schools reach the voting age. Then it is to be expected that the Portuguese and Spaniards will take a larger and larger interest in political affairs, and the Oriental children born on the islands subsequent to June 14, 1900, will take an active part in legislation. The number of children of Orientals eligible as future voters is now large. The voting strength at present lies with the Hawaiians and part Hawaiians, who comprise nearly three-fourths of the electors.

The estimate for 1908 is as follows:

Voters in 1908.

Hawaiian and part Hawaiian	9,000
American	2,000
Teutonic European	1,200
Portuguese	800
Chinese	264
Total	13,264

The Americans—that is, those who have come from the United States and who presumably have been brought up under republican institutions—form only 15 per cent of the voters.

The variation in number of voters is shown by the following statement:

Registered voters, 1900 to 1908.

1900	10,180
1902	12,612
1904	13,449
1906	13,577
1908	13,264

As to the citizenship of the future, an indication is shown in the nationality of the school children, as follows:

Nationality of school children, 1908.

	Per cent.
Hawaiian	20
Part Hawaiian	15
American and Teutonic-English	5
Portuguese	19
Japanese	24
Chinese	11
All others	6
Total	100

Not all of the oriental school children were born in the United States, and a considerable portion of them will probably return to Japan and China, but the next generation of voters will have a large proportion of Orientals. The small proportion of school children of direct American ancestry is very significant in this connection. As to the attitude which may be taken by these future voters on territorial and national questions it is impossible to predict, but it is surely a national duty and a needed precaution to attempt to increase and diffuse patriotic ideals and conceptions of the duties of citizenship, such as is being done to a notable degree in the public schools of the Territory.

The social condition of the inhabitants is indicated in part by their religious affiliations. Accurate figures are not obtainable, but from

the census of 1896 and estimates based upon it it is found that practically 40 per cent of the population support some oriental religion, such as Buddhism or Confucianism, 24 per cent are Catholics, 21 per cent Protestants, 5 per cent Mormon, and 10 per cent have no affiliation.

Taking only the native Hawaiians and part Hawaiians, the religious preferences are indicated by the fact that 20 per cent report no affiliations, 40 per cent Protestant, 28 per cent Catholic, and 12 per cent Mormon.

INDUSTRIES.

Agriculture forms practically the only general industry on the islands, although there is a certain amount of manufacturing in con-

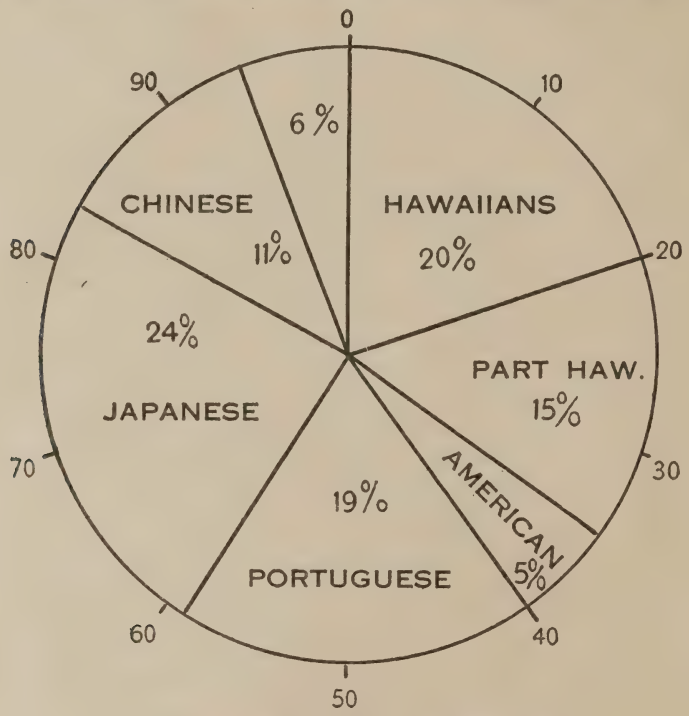

FIG. 9.—Nationality of school children, 1908.

nection with it and a considerable amount of transportation incidental to handling the product. A notable exception in the case of manufacturing is the development of the Honolulu Iron Works along the line of sugar-making machinery. Large mills have been built in Honolulu and shipped to remote parts of the world.

SUGAR.

Sugar is the principal industry, over nine-tenths of the products of the island being raw or refined sugars. The business is one which under present conditions requires not only large capital but also a very large amount of manual labor. Being carried on in competition with countries where such labor is very cheap, the wages paid must

be correspondingly low. The islands have the benefit of the federal protective tariff on sugar and it is presumable that a continuation of the industry rests largely upon this somewhat artificial and possibly insecure basis. The production of sugar has increased rapidly from 282,807 tons in 1899 to 521,123 tons in 1908. (See fig. 10, p. 40.)

The business is conducted by about 65 corporations organized with capital of from $200,000 to $400,000 each and total of $150,000,000, chartered usually under the laws of California. The stock of these is held by 7,000 persons living largely in California and in the islands, and possibly to a less extent in England and Germany. Some of the plantations have made large profits and have declared dividends up to 2 per cent per month. Others have never paid expenses and some have gone into bankruptcy. Sugar stocks have been the favorite form of speculation (not to say gambling) in the islands. The production of sugar in 1908—521,123 tons valued at over $40,000,000—is equal to nearly one-fifth of the amount consumed in the United States.

About one-half the area producing sugar cane is irrigated or, say, 105,000 out of 213,000 acres. This irrigated land was reclaimed from aridity by private enterprise at a cost of about $15,000,000 or about $140 per acre. In comparison with this it may be noted that the cost of reclamation in the mainland—say for sugar-beet culture—has been about $40 per acre.

The sugar produced per acre ranges from less than 1 ton to 10 tons and averaged for 1908 in round numbers 4½ tons per acre. From irrigated land the average was 5¾ tons per acre and for nonirrigated land 3 tons per acre. Only about one-half of the sugar land produces each year. The value of the sugar is about $70 per ton, or from $280 to $420 per acre every other year. Over one-half the cost of the sugar is in labor, this being about 60 per cent, but the proportion is gradually decreasing as labor-saving machinery is introduced and laborers become more efficient.

A large item of expense is that for fertilizers, over $2,000,000 per year being expended for this purpose. An average of $4.65 per ton of sugar, or $22.20 per acre of crop.

It requires from 18 to 30 months to mature a crop of sugar cane, so that the number of acres cultivated for each crop does not represent the total area in use. For example, the crop of 1906 came from 96,000 acres out of a little less than 200,000 acres, part of which was lying fallow and part in young cane.

RICE.

Second in importance to sugar, but a long way behind it in value, is the production of rice, estimated at $2,500,000, as against $40,000,000 for sugar. This industry is wholly in the hands of Chinese, who rent many of the marshes or wet lands formerly used by the natives for raising taro. The plants are all set by hand, and the grain is handled in a most primitive way, little or no machinery being used. An acre of good land will produce two crops a year at a value of $200 to $300 per acre. About 10,000 acres are cultivated mainly on Oahu and Kauai. The rentals are from $10 to $50 per acre per annum, with water. The fields are submerged for most of the growing season and require a large quantity of water.

DIVERSIFIED INDUSTRIES.

From the time of the discovery of the islands by white men attempts have been made to introduce or develop various agricultural

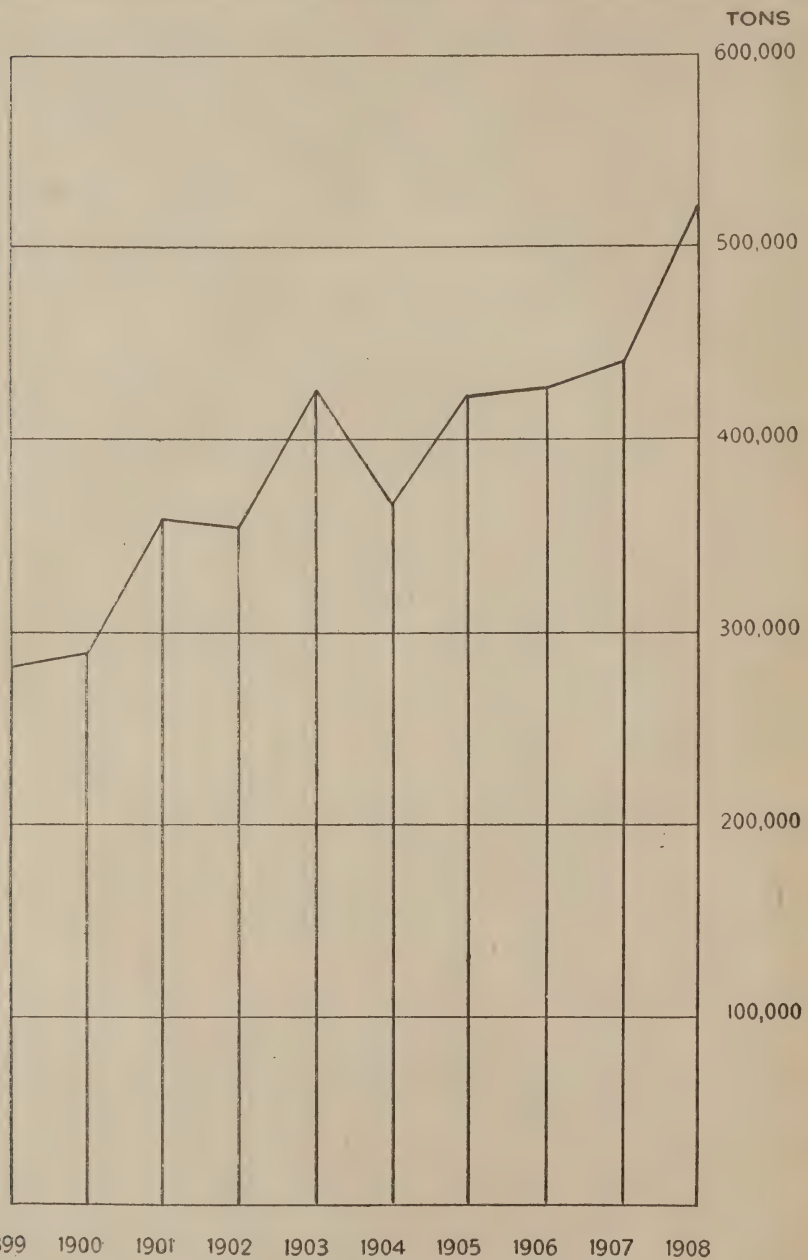

FIG. 10.—Production of sugar from 1899 to 1908.

industries, as the raising of rice, cotton, pineapples, coffee, tobacco, and other crops suited to the tropical conditions. Greatest success has been obtained with the sugar cane, and the large profits have re-

sulted in directing principal attention to this crop. Continued efforts have, however, been given with varying success to the other possible sources of revenue, as it has been appreciated that dependence upon a single industry which in turn rests upon a protective tariff and upon oriental labor is not a highly desirable condition. The difficulty of obtaining adequate labor, the constant struggle against insect pests and blights, the expense of transportation, the former unsettled political conditions, have resulted in a slow progress, but there are still optimistic advocates of diversified farming who expect, through the operations of the experiment stations stimulating and supplementing individual efforts, to finally surmount all obstacles. The rich soil and excellent climate promise success if only sufficient skill or knowledge can be had to overcome what seems to be minor difficulties.

Various tropical and semitropical fruits are produced successfully and meet ready sale, such as bananas, dates, oranges, lemons, grapes, cocoanuts, and avacados, English walnuts, apples, and plums grown in the uplands, rubber, tobacco, and vanilla are being produced in small quantities, and with the hope of extending these industries. Hay and forage crops are successful, but all are awaiting the establishment of a steady market and better transportation by wagon road, railroads, and steamship lines.

The annual production of coffee is about 1,500 tons, valued at $300,000. About 4,500 acres are in bearing trees, all in the humid portion of the islands. The prices have been so low that many coffee raisers have gone out of the business, but the area planted to coffee is now slowly increasing as the Hawaiian coffee is being better known. It is well adapted to white labor and to small homestead conditions. With persistent organized effort this industry will undoubtedly become more important. It has required years of experiment to determine the most favorable localities and conditions of humidity to reach the best results. Many of the earlier plantations were in places too rainy for success.

The pineapple industry is now regarded as offering the best opportunities for the white settler. There are now 9 pineapple canneries in the Territory and nearly 5,765 acres in pineapples. Of this 85 per cent is controlled by small corporations and about 7 per cent by Japanese. The area planted is divided about as follows: Hawaii, 350 acres; Oahu, 4,565 acres; Maui, 600 acres, and Kauai, 250 acres. At present prices the value of the 1908 crop canned would approximate $1,250,000. The total output is about 17,000 tons.

The sisal industry is one which is looked to as furnishing opportunities for the utilization of large areas of land which otherwise would lie waste. The plant requires relatively little water; as low, it is claimed, as 6 to 9 inches of annual rainfall will produce fair results. It flourishes best, however, when it has a larger rainfall. It responds quickly to occasional showers, but during long periods of droughts the plants stop growing and apparently show no injurious effects. It will grow on very stony soil and appears to be well adapted to the lowlands near the seashore which are underlain with coral or where the rocks nearly cover the surface. There the plant inserts its roots between the loose blocks and seeks nourishment from the thin soil.

Several small mills have been constructed for extracting the fiber but the mechanical devices for this purpose are by no means satisfactory. Improvements are constantly being made tending to reduce the amount of hand labor. The fiber is excellent in quality, commanding, it is claimed, a higher price than the best from Yucatan.

The total imports of raw fibers into the United States is stated to amount to $35,000,000. Of this amount from $13,000,000 to $15,000,000 is paid for sisal, which is admitted without tariff. It is believed that on the islands there are upward of half a million acres capable of producing sisal and having little value for other purposes. From this there could be obtained a product of 150,000 tons, which at 6 cents per pound would produce $18,000,000. The prices now paid range from a little over 6 cents up to 8 cents per pound.

LABOR.

For a half century the question of labor has been and still is a most perplexing problem. The production of sugar, the main business of the islands, is under present conditions dependent upon cheap labor, mainly that of Orientals paid $17 or more in addition to house, water, and medical attendance. There are approximately 95,000 of these aliens, over half of the entire population of the islands. Besides the Orientals there are 27,000 Portuguese, including with this Spaniards and others of Latin tongues. These men receive a slightly higher wage, $22 per month and upward, and demand perhaps better consideration than the Orientals, as they are eligible for citizenship and are more effective as laborers.

With the rigid enforcement of the Chinese-exclusion act, the stopping of emigration from Japan, and the prevention of contract labor from abroad, the supply of cheap laborers has been practically cut off. Attempts are being made to bring immigrants from San Francisco or even from New York, securing them as they arrive from Europe. The difficulty of getting these people across to the islands without losing them to other employers is very serious.

The labor market is now practically surrounded by an almost impassable barrier; the number of laborers who are willing to work in the fields at low wages is decreasing, while the demand is steadily increasing. The planters, it is understood, have a fixed scale and theoretically at least do not compete among themselves, although by various methods of contract or bonus for length of service, there is a tendency to increase indirectly the wages paid. It is generally recognized that higher and higher grades of laborers must be secured as the Orientals decrease through return home or through entering into other industries.

Systematic efforts have been made to improve the condition of the migratory laborers and to induce them to remain in a given locality. The Japanese are readily moved and are quick to resent any grievance. By impulsively shifting from place to place their effectiveness is far less than though they stayed on any one plantation where they could become familiar with conditions and the requirements of the manager. Their capacity to work effectively without constant oversight and their initiation is reported to be somewhat lower than that of the Portuguese.

In the case of the Portuguese and similar laborers not only is the wage scale somewhat higher than that paid the Orientals, corresponding to their greater efficiency, but inducements have been made in the way of offering to them houses and small tracts of land on condition that they will live on the ground for two or more years and will make moderate payments in monthly installments. The offers of this kind have frequently been regarded with suspicion, but in a few cases they have been accepted. The average laborer would rather have a dollar or two more a month in cash than twice its equivalent in real property, as he is fearful of being tied down or he suspects some ulterior motive.

In some localities the offers of free land from the Government have been accepted and small bodies of laborers are acquiring title. On one of the plantations railroad facilities have been provided by which the laborers located in their homes can reach other points of work if they so desire. Where the laborer finds he is thus free to seek other occupation he usually prefers to stay near home, work on the adjacent plantation, and with the help of his family cultivate his own little garden. Liberal treatment in such directions has been followed by more effective work and by less desire to move about from plantation to plantation.

On the Olaa plantation in Hawaii an acre of ground is given to men who have worked for three years at regular wages. Over 50 Portuguese and 30 Spanish have availed themselves of this opportunity. With decrease in supply of labor from the outside the efficiency of the individual workers now employed is steadily increasing, due to the more settled condition and to various other causes, so that now it is believed that the individual Japanese worker, for example, accomplishes 20 per cent more than he did when he first came to the islands. This is due in part to the fact that many of the Japanese are taking small contracts for cultivating or cutting the cane; with aroused personal interest they are doing more and better work; also it is asserted that during the war with Russia the Japanese laborers were more or less excited and devoted considerable time to war news. After the cessation of the war and with the stimulus of rumors of possible troubles with the United States, the laborers resumed work with renewed vigor with the idea of accumulating as much money as possible in view of early return to their own country.

With the increase of effectiveness of labor through better work on the part of the Orientals and higher grade of labor for the Latins, there is coming about also a reduction in the amount of heavy manual work. For example, the planters' experiment station has discovered that the stripping of the cane, a very laborious process, does not add to its value, but even the reverse. With the elimination of the stripping, possibly 12 per cent of the labor on the plantation will be reduced. The burning of the cane immediately before cutting tends to reduce the amount of material to be handled. Machinery is being introduced for loading cane as it is for unloading, and every possible effort is being made to utilize labor-saving devices, although it must be confessed that the progress in this direction has not been as marked as it has been in many others.

The sentiment of the public as well as of the planters is rapidly crystallizing into well-defined movements to bring about not merely

a better physical condition of the laborers, but also to bring to the islands only such men as are capable of becoming citizens.

It can not be said that action along this line on the part of employers is wholly altruistic. It is due in part to the recognition of the fact that the public welfare demands that the greater part of the population shall be no longer alien; as voters the field laborers must ultimately yield a powerful influence. The evolution of the sugar industry seems to permit or even demand a higher grade of laborer. There is no doubt that the planters as a whole, actuated in part by patriotic motives, will gladly employ a higher type of men if they can be had.

The factors working together for raising the standard of labor are national, territorial, and individual: National in the exclusion of Orientals, territorial in the supervision of immigration and execution of public health and quarantine requirements, individual in the work being done singly by the planters or through their association, notably in experimental work.

One of the first steps in advance is that of improving the laborers' quarters and of providing the more ambitious men with small homes, where they can own the ground and become independent. The education of the children of the laborers is also resulting in appreciation of and demands for better housing conditions, but the effect of this education must be to keep a considerable part of the next generation out of the fields unless by that time labor-saving devices have been developed to a point where manual labor is more largely replaced by exercise of intelligence.

The increase of product of sugar per individual employed in the field is illustrated by the fact that in 1904 about 8 tons of sugar were produced per man employed, and in 1908 there were 11 tons per man.

IMPORTING LABOR.

The labor question is by no means new now, nor is it wholly an outgrowth of annexation. From the very beginning of the sugar industry it was seen that the dependence could not be put upon native labor alone. The natives were not only decreasing in number, but were unwilling to work steadily in the fields. As early as 1850 the legislative assembly made provisions for contract labor. In that year the Royal Hawaiian Agricultural Society was founded with a view to promoting the interest of the planters. Under their auspices in 1852 Chinese to the number of 293 were brought in, followed by others annually, until in 1865 the board of immigration was created, and the Government entering more and more into the details of immigration finally became practically an employment agency, seeking labor in all parts of the world, notably from China, Polynesia, Japan, Portugal, Spain, Germany, Norway, and Porto Rico.

In all over 180,000 immigrants have been brought to the islands since 1852, at a total cost of over $9,000,000, or $50 each.

The cost of bringing in the Japanese has been estimated at $70 per individual, of Chinese $75, and of Portuguese $115. Of the total imported, probably a half have gone home, others have died or left the fields and gone into varied industries, leaving about 45,000 laborers on the plantations.

One of the latest and most successful attempts to bring in labor has been that of introducing Portuguese and Spanish. Three steamers brought in during 1907 an aggregate of 1,400 men, 1,143 women, 2,141 children, in all 4,684 individuals. This was done at an average cost, including the general superintendence of the work, of $62 per individual or a little over $200 for each adult male. The wages paid these men will average at first probably about $20 per month.

As part of the systematic efforts of the territorial immigration commission, there have been brought back to the islands from San Francisco a considerable number of Portuguese laborers who left the islands to seek work on the mainland, hearing of the high prices paid in California after the earthquake. These people were glad to return to the islands, but did not have sufficient funds. The Territory paid for their return passage at an average cost of $52 for each adult male, or $28 for each individual. There were thus returned 187 men, 63 women, and 98 children.

HOME MAKING.

The supreme need of the islands from the standpoint of the national interest is that of increasing the number of citizens owning homes upon the lands. The relatively great proportion of laborers who are not citizens and the fact that there is such a small number of citizens who are landowners and who have been brought up under democratic institutions, forms a source of weakness. Every possible effort should be made by public and private interests to put upon the land the best obtainable men, who will live upon small farms, cultivate the soil and become independent, self-supporting citizens. This need has long been recognized; many attempts have been made to remedy conditions, but most of these have not been successful, owing to a variety of reasons.

The development of an agricultural citizen class—intermediate between the corporations owning large sugar plantations and the landless migratory laborer—is favored by natural conditions and by popular sentiment. The chief obstacles arise from the overshadowing interests of the great sugar industry and the resulting presence of oriental or other low-grade labor, which tends continually to crowd out or take the place of the citizen engaged in individual enterprise. The Chinese in past years gradually replaced the small farmer and the local tradesman and mechanic. In turn he is being displaced by the Japanese, who, coming originally to labor on the plantation, sought easier work, took small contracts, started little stores to supply his countrymen, and now is getting into all agricultural lines excepting rice.

It must be admitted that as matters now stand the newcomer finds difficulty in getting located. He is welcomed and treated with hospitality and if he is a laboring man or mechanic may find work, but the demand for such men is not large. If he is a farmer he will be more than welcome in sentiment, but from a business standpoint he will find it difficult to learn of a piece of land which can be secured on reasonable terms. It is probable that he will fall in with several of that numerous class of men who, not having succeeded themselves, spend their time in telling others of the disadvantages. This is a

common condition throughout all countries which have reached a certain stage of development and where new men attempt to secure a foothold. In initiating a number of the reclamation projects on the mainland which have since proved successful, one of the first obstacles encountered lay in the old inhabitants, who seemed to make it a business to scoff at the efforts of the newcomers and to assure them that the conditions were such that they could not make a living. The fact that they had failed was to them proof that no one else could succeed.

The attitude of the present landowners toward increase of settlement is favorable in theory. Each man concedes that it is for the public good to subdivide some of the larger holdings and to put these in the hands of the best class of citizens. It is, however, inseparable from human nature for Jones to think that Smith should subdivide his land first. There are always some special reasons why Jones thinks that his case is exceptional and he should not be called upon to make possible concession to the public good.

There has been and possibly now is a fear among a few plantation managers that the small farmer will become a competitor in bidding for the services of the laborers brought to the plantation at great expense. There is some reason in this, but in the long run it is believed that the dangers imagined from this source will be more than outweighed by other benefits.

The territorial government is attempting through the wise use of the public lands to promote settlement, and has from time to time modified the laws with this end in view. The practical difficulties are great, but, nevertheless, continued efforts are being made and every possible solution is being considered. The commissioner of the public lands, having the disposal of lands in direct charge, is studying from time to time the best method of subdividing each piece of government land as the lease expires, but, with limited assistance and the restrictions necessarily imposed, these results come slowly.

The chief obstacles to more rapid subdivision of lands and settlement of the islands lie, first, in the prevailing ignorance concerning the country and its possibilities; second, in the present character of the land ownership; third, in the presence of a great body of Orientals; fourth, in transportation problems; and, fifth, in the absence of local or agricultural banks.

First. Although the islands have been part of the United States for more than ten years, it is probable that relatively few persons on the mainland seeking new homes or larger opportunities are aware of the attractions afforded by the climate and fertile soil. This condition is being remedied by active efforts of the Territory and of various semiofficial organizations, such as the promotion committee, which is circulating literature and calling attention to the opportunities.

Second. The chief difficulty met by a prospective settler upon reaching the islands is to find any piece of land available for his use. It is true that the territorial government is subdividing lands and offering these from time to time, but most of the attractive places are immediately taken by men resident on the islands, some of whom may already have a home elsewhere. There is practically no private land for sale, but there is some offered for lease at what appear to be very high prices.

Third. The presence of the oriental laborer, forming the great mass of population, produces an artificial condition of social and

business life not conducive to settlement by whites. In the arid States of the mainland where men take up land and make it valuable by their own labor, every man is on the same social plane with his neighbor and vies with him in physical as well as mental energies expended in daily labor. In the island, however, where practically all the physical labor is performed by Orientals, the tendency is for the white settler to endeavor to have his work done by Orientals. He tries to secure a larger piece of land than he could cultivate himself and to work it by cheap labor rather than take the small area and intelligently till it by his personal efforts. It is not that the climatic conditions are unfavorable to physical exertion, but largely because it is not customary for the white man to do work which can be performed by Japanese.

Another unfavorable condition growing out of the presence of the Orientals is that they are willing to pay large rent for a piece of land instead of trying to own it, and are content with relatively small earnings. The white man can not compete with them in their own lines. His standard of living is so different that although he may possess superior intelligence he can not profitably utilize the ground to the same degree as his oriental neighbor.

Fourth. The problem of transportation is one which is ever present in a growing community. The present facilities of communication between the islands are in their way excellent and are constantly improving. There are also on some of the islands the beginnings of railroads more or less encircling them and bringing the products to convenient ports. There are only three of these, however, where steamers can lie at a dock, namely, at Honolulu, on Oahu, at Hilo, on Hawaii, and at Kahului, on Maui. At all other ports on the three islands named, and at all points on the other islands, the products must be lightered, usually in small boats, resulting in considerable expense and some uncertainty and danger in transfer.

There are on most of the islands excellent wagon roads and others projected to reach the productive land. These roads, originally built by the provisional government and continued by the Territory, are now in the hands of county officials. Some are well maintained, on others the funds have not been effectively expended. The cost of transporting products, therefore, to the main lines of trade is frequently high, but with increase of production it is proper to expect that the facilities will be improved and the cost notably lowered.

Fifth. There are practically no banks or institutions advancing money to farmers. The sugar industry is financed by a few large agencies who have little or no interest outside of this particular line. The fruit raiser or packer or the small farmer does not have the facilities of obtaining money possessed in most agricultural communities on the mainland. The Japanese have already appreciated this fact, and by white assistance are starting a bank to help their fellow countrymen finance sugar-planting contracts and similar enterprises.

HOME MAKING ON THE PUBLIC LANDS.

The apparently obvious thing to do, and the action proposed by every person when he first considers the subject, is to cut up the public lands as soon as the leases run out and distribute the lands in small tracts to citizens. For example, the Territory owns 34,000 acres

of rich land now leased to the plantations and cultivated in sugar cane. This land has a value of from $50 to $200 per acre, and would yield an annual rental of $8 or $10 per acre or even more. The question is frequently asked, Why not cut up this cane land into tracts of 40-acre homesteads? This seems to be a simple way of treating the problem. It has, however, been put to trial, without success. In general effect it has proved as advantageous to the public as it would have been to give to each applicant $2,000 to $8,000 in gold. The recipient of this gift would be greatly pleased, but the public treasury would be depleted by this amount.

The giving away of this rich, highly cultivated land upon condition of residence upon it has resulted in the recipient making some indirect arrangement by which he virtually leases to the adjacent plantation the land which has been given him. Pending the time of securing complete title he establishes a nominal residence with the apparent intention of selling the land as soon as he can obtain title from the government. The home has usually consisted of the cheapest possible house or shack in which a human being can sleep occasionally and occupying the least possible amount of land, the remainder being devoted to sugar cane or other plantation purposes. The homesteader has not added to the value of the land in any respect, either by his personal labor or by intelligent supervision of the work of others. The conditions are similar to those on the mainland where homestead entries were received on valuable timber lands. Merely nominal residence was established, and when title was received the land was promptly sold to some large lumber company. As far as benefit to the commonwealth was concerned the government might better have sold the land directly and converted the proceeds to public uses.

The experience had in these lines illustrates the fact that lands which are most valuable for some established and highly profitable line of industry will not be actually used as homesteads even if subdivided and given to applicants. No way has yet been devised for keeping a man on his homestead after he obtains title if he believes that he can make money more easily by selling his land to some corporation. To have a successful homestead, one which is a benefit in increasing the prosperity of any country, it is necessary to have, first, a man who really desires to own and cultivate a piece of land, and who has the ability, physical and to a certain extent financial, so to do; second, the land open to homestead entry must be of such quality and so located that the entryman can raise food for home consumption and will prefer to live at home; and third, the surrounding conditions of market and transportation must be such that the products can be sold at prices profitable enough to support his family. If he can make as good or nearly as good a living by renting his land he will probably do so. Nothing can keep a homesteader on his land but the fact that this is, in his own opinion, the most suitable place to live, and when the earnings which he receives from cultivating the soil are higher than those obtained in any other way.

One of the difficulties of bringing about actual homesteading is that inherent in distinguishing between the bona fide settler and the speculator. At present the territorial laws do not limit the number of homesteads that a man can take, with the result that having secured one homestead the owner can dispose of it and get another and

another in succession without adding to the population of the country. A somewhat active sentiment on the part of the majority of citizens is to the effect that the preference should be given to natives. The idea prominent in public discussions when homesteads are mentioned is that the public lands should be divided up among the present population.

There is no question but that each native should have a home and sufficient area for the support of his family, but it is not adding to the strength of the commonwealth to divide land among men who will not live upon it and improve it. The policy recently adopted of leasing, for a term of 999 years, small areas to the natives has proved most beneficial, both to them and to the public. In this way a man and his family may have sufficient land for their support if they use industry, and this land will remain in the family as long as it is used as a home. This policy appears to put a stop to much of the speculation which has prevented effective homesteading in the past.

The disposal of the public lands in a limited number of small tracts from time to time as leases expire has prevented any general advertising of the fact that public land is available and thus has not attracted the attention of possible settlers from the mainland. It appears probable that if any considerable number of farm units could be disposed of by lot, it would be possible to attract the attention of desirable settlers and bring into the islands the class of men urgently needed.

IS HOME-MAKING PRACTICABLE?

Is it practicable in face of existing conditions of land ownership, of character of population, and of labor to greatly increase the number of small independent farmers, men who can and will maintain a relatively high standard of living? Can the pioneer white farmer get a foothold on the islands where good agricultural land now rents each year at prices from $5 to $50 per acre? Will he bring his family to a community composed largely of Asiatics or the poorer grades of Latin races? Will he be content to labor in his field when most men of his race now act as overseers or employers and where coolies or peasants are hired for all manual work? Will he, on gaining full title to his homestead sell or lease to an Oriental, or be gradually crowded out, as has been the white mechanic and shopkeeper? It is evident that unless he can obtain a foothold and will be able to maintain the standard of living and the social and civic ideals of the Republic, there is little to be gained by attempts to merely increase population.

There is little or nothing in the climate to prevent attaining in the islands as great or even greater success in small farming as that reached on the mainland. There are hotter parts of California and more enervating conditions in various parts of the newly settled West. There are similar difficulties in lack of transportation or in physical obstacles to be overcome. The problem is not so much one of natural environment but of artificial or civic conditions. As a consequence the remedy to be applied or the impediments to be removed are mainly artificial or social. The bringing about of the desired condition of a larger population and a greater percentage of intelligent

voters must come in a different way from that on the mainland. There a high development was reached by the single-handed combat of each pioneer with his natural environment. On the islands, as above stated, the chief obstacles are of human or social origin, and a broad, intelligent cooperation must be had of all civic organizations combining toward the common end. In this should be united the agencies of the nation, the guardian of the Territory, as well as those of the Territory itself and the commercial or semipublic organizations of the people on the islands.

Progress can not be made toward securing a larger settlement by breaking down any of the existing industries or taking away lands now devoted to high grades of agriculture. What is needed is to supplement and add to the present industries rather than interfere with them, or, putting the matter in more concrete form, it is not for the best public policy to try to cut down the area in sugar for the purpose of raising some other less valuable crop. Some well-intentioned persons have argued that in order to increase the desirable population of the islands the sugar plantations must be restricted and the lands now in sugar cane divided up. It is believed that this is neither practicable nor desirable. The sugar industry is the main support of the islands and will probably so remain until conditions have radically changed throughout the entire country. On the other hand, there are known to be large tracts of land which are not being put to their best use, largely because of lack of sufficient moisture. These are held, generally, by estates or by the government, and in some respect the problem of their use is similar to that which has been successfully met by reclamation under the Federal Government. The underlying principles there have not been to deprive any industry of needed land but to take the lands which otherwise would be waste and desolate, bring water to them, and make it possible for men with skill and energy to put the lands in such condition that they become valuable and are capable of supporting the families of their owners.

SUMMARY.

The Hawaiian Islands are a part of the United States forming the Territory of Hawaii. Though small in area the Territory, from its location, has a peculiar importance in the national welfare and defense. It is agricultural and now devoted practically to one industry—sugar.

The prosperity of the sugar industry and hence of the Territory rests on the unstable basis of the federal protective tariff and a migratory alien labor class composed mainly of Orientals.

There is a conspicuous lack of the body of citizenship which has made possible the existence of the American commonwealth, namely, the "plain people," property owners of moderate means with thrift, energy, and high civic ideals.

The climatic conditions and natural resources are highly favorable to the increase of diversified agriculture and to the building up of a class of independent small farmers—needed for national growth and defense.

The artificial conditions—those of human control—social and otherwise, such as arise from the presence of a preponderance of Orientals, are not now favorable to the success of this class.

It is possible by wiser use of natural resources and broader statesmanship to remove many obstacles and to stimulate the increase of property-owning citizens.

This is being done in part by the territorial government utilizing its public lands as far as practicable for homesteads, but, being done in a small way, it is not bringing to the Territory the class of citizens who are building up other Territories.

The reclamation of considerable areas of public land by the Federal Government, as is done elsewhere under the terms of the act of June 17, 1902, would attract this class of small farmers and stimulate diversified agricultural industries as no other known agency could.

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